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Sport Fishery Abstracts

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Sport Fishery Abstracts

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Sport Fishery Abstracts is intended to furnish fishery biologists in government agencies and educational institutions with abstracts of the current literature in sport fishery research and management. Abstracts of papers on limnology, ecology, natural history and other fields of specialization will be included when the subject has application to the conservation of sport fish and the restoration of sport fishing.

Initials following an abstract are those of abstractors whose names are listed on the last page. Those abstracts without a source indicated were prepared by the Editorial staff. One volume consisting of not more than four numbers will be issued each year. Each number contains separate Author and Subject indexes, with the final number of each volume containing cumulative indexes.

The last number of each volume contains a list of publications screened for appropriate material. Suggestions for improving the usefulness and coverage of Sport Fishery Abstracts are solicited.

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Prepared in the Branch of Federal Aid
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943. Dowell, Virgil Eugene. 1957. ACTIVITY PATTERNS AND DISTRIBUTION OF THE FISHES IN THE BUNCOMBE CREEK ARM OF LAKE TEXOMA. Dissertation Abstr., Vol. 17, No. 4, pp. 919-920.

A study was made of the activity patterns and distribution of the fishes in the Buncombe Creek arm of Lake Texoma, Oklahoma, from June, 1953, to August, 1955. Gill nets were used to collect the large fishes and various types of seines were the primary means used to collect the small fishes. The gill nets were set at various depths from the surface to the bottom at 13 different netting stations extending from the mouth of the creek to the upper limits of inundation. Lifts were made twice daily.

A total of 50 species and 1 hybrid representing 30 genera and 14 families was collected. Of these, 23 species were collected in gill nets, and data are presented on the seasonal and daily activity patterns of each. The percentages of the total gill-net catch of all species which the various species contributed were: gizzard shad, 27; goldeye, 17; white bass, 14; white crappie, 10; river carpsucker, 8; all others, 24. The seasonal activity varied with the different species, but usually was highest in the spring and fall. Night netting accounted for 85 percent of the total catch of all species. In general, species of the family Centrarchidae were less active by night and more active by day than other species, but, of these, only the bluegill (Lepomis macrochirus) and the longear sunfish (L. megalotis) were collected in greater numbers by day than by night. It seems quite certain that the low day catch can be partially attributed to the ability of the fishes to see and evade the nets.

Though data were collected on the upstream-downstream and in cove-out of cove movements of each species gill-netted, no definite trends in the direction of movement could be determined for most species.

The depth distribution was determined for 20 of the 23 species gill-netted; by months for the more abundant species, by seasons for less abundant species, and the data of all months were combined for those species poorly represented in the catch. Since nets were set at all depths in water of different depths, it was possible to plot these data on diagrams representing diagramatic cross sections of the lake in such a manner that each fish was placed at the approximate locality from which it was collected in relation to surface and bottom.

A total of 47 species (including one hybrid) was collected in seines. The upstream-downstream distribution was determined for each of these.

In addition to collecting fishes, year-round data were collected on the water temperature at all depths. It was found that during the late fall and winter months the water temperature of Buncombe Creek is essentially uniform from top to bottom, but thermoclines may develop during the spring, summer, and early fall if there is an extended period of high temperatures and little wind. These readily disappear with increased wave action. (Auth. abst.)

944. Curtin, Charles Byron. 1956. THE NUMBERS AND DISTRIBUTION OF GILL TREMATODES ON THE CARP, CYPRINUS CARPIO L., COLLECTED FROM THREE DIFFERENT LOCALITIES. Dissertation Abstr., Vol. 16, No. 12, pp. 2561-2562.

Pymatuning Lake, Pennsylvania, has been divided into three different areas ecologically on the basis of variances in physical and chemical characteristics. Carp are particularly abundant in these waters and afforded an opportunity for a critical study of fish parasites. A study was conducted to determine if differences in the environments of these three areas or differences in the sex of the host were sufficient causes to account for the differences in the numbers of parasites on the gills of the carp. Two species of monogenetic trematodes were found to be common on the gills of this fish. They were identified as Dactylogyrus sp. and Gyrodactylus elegans Nord. All fish examined were sexually mature specimens and the condition factor was determined for each individual. Records were maintained as to sex of host, length, weight, habitat, and numbers and species of parasite for each fish. Tests for significance between lakes, sex and parasites also within lakes, sex, and parasites were run on the data using an analysis of variance with single classification. The results established that there were no significant differences in the numbers of parasites from the carp from the different locations or from either sex. Whatever environmental conditions or activities of the trematodes were responsible for the varying numbers of trematodes found on the carp, it was something different from those differences which were to be found between the environmental conditions of the three lakes or between the sexes. Dactylogyrus was found to be more common to Sanctuary Lake while Gyrodactylus was the dominant species of parasite from Lower Lake. Carp from the Middle Lake were intermediate in the numbers of parasites and the majority of hosts were found to have a bacterial infection of the gills. The effect of the bacterial infection on the numbers and distribution of the gill trematodes from carp taken in this location could not be determined. Sample sizes were estimated and found to be adequate except for Dactylogyrus from Lower Lake. A positive association of the two species was established using Cole's formulae for the measurement of interspecific association. (Auth. abst.)

945. Montgomery, William Roark. 1956. STUDIES ON DIGENETIC TREMATODES FROM MARINE FISHES OF LA JOLLA, CALIFORNIA. Dissertation Abstr., Vol. 16, No. 12, p. 2564.

Nine hundred and fifty-seven specimens of fishes were examined for parasites at Scripps Institution of Oceanography at La Jolla, California, during the summer of 1953. These fishes included 55 different species distributed in 48 genera and 29 families.

Approximately 40 species of digenetic trematodes were collected. Of these, 22 species are dealt with in this thesis. Five new genera and 11 new species are named and described.

Thirteen new hosts are reported for a total of six previously known species.

LaJolla, California, is a new locality record for seven previously known species.

Opechona xesuri Yamaguti, is transferred to the genus Lepocreadium.

A host-parasite list is given.

Of the 38 species of digenetic trematodes now known from La Jolla, 18 are known elsewhere. Nine species occur also in the American Tropical Pacific south of California; four species at Tortugas, Florida; four species in Japan; three species in Northern California waters; and three species in the North Atlantic. Thus, on the basis of present knowledge, the trematode fauna at La Jolla has its greatest affinities with faunas to the south (tropical American Pacific), with some resemblance also to trematodes of the Gulf of Mexico and Japan. (Auth. abst.)

946. Outten, Lora Milton. 1956. STUDIES OF THE LIFE HISTORY OF THE CYPRINID FISHES NOTROPIS COCCOGENIS, GALACTURUS, AND RUBRICROCEUS. Dissertation Abstr., Vol. 16, No. 12, pp. 2564-2565.

This study of the cyprinid fishes Notropis coccogenis (Cope), Notropis galacturus (Cope), and Notropis rubricroceus (Cope) refers particularly to their occurrence in the upper Tennessee River system and deals with their synonymy, distribution, life history, and habits. Collections studied were taken mostly in tributaries of the French Broad River near Mars Hill, Madison County, North Carolina, from September 1949 to June 1955, and were supplemented by material from the Cornell University Fish Collection. Standard length, sex, age, and maturity were determined for 6395 specimens. Studies of food habits and fecundity utilized 158 and 112 specimens respectively. Habitat relationships and spawning behavior were observed.

The three species occur in the upper Tennessee River system. Specimens of coccogenis also have been taken in the Catawba, and coccogenis and galacturus in the New river headwaters. In addition galacturus is found in the Cumberland and White, listed as questionable from the Mississippi and reported from the Savannah and St. Francis River systems.

Individuals of the three species are active at levels from about midway the depth to the surface of medium-sized mountain streams. Associates include populations of Notropis leuciodus and Hybopsis micropogon. Members of the species studied were more abundant near riffles; coccogenis is moderately large, galacturus in the deeper, and rubricroceus in somewhat shallow pools.

During the spawning season mature males were more brightly colored and had well-developed tubercles along the dorsal surface of the pectoral fin rays. The snout of males of galacturus and of rubricroceus was slightly prolonged, and that of coccogenis and of galacturus had moderately large tubercles. The pelvic fins of males of galacturus and of rubricroceus are longer than those of the females. Males of rubricroceus have the pectoral fin rays enlarged. Females of the three species are paler and without well-developed tubercles. Males generally equalled or slightly exceeded females of the same year class in length.

Groups of males of coccogenis and of rubricroceus held territories over gravel nests of Hybopsis micropogon; the former from June 7 to July 17, with spawning observed from June 10 to 12 at water temperatures from 70° to 80° F.; the latter spawned from May 25 to July 21 at water temperatures from 66° to 86° F. Individual males of galacturus held territories under submerged surfaces as a floating tree limb and the projecting edge of a boulder. Spawning was observed from May 25 to June 28 at water temperatures from 75° to 82° F. Sixteen nests of galacturus had 127 to 382 eggs each.

In late spring the ovaries of large females of coccogenis contained from 300 to 1636 mature eggs, galacturus from 400 to 1815, and rubricroceus from 445 to 1174. Mature eggs of each species in formalin measured about 1.5 mm. in diameter. Larvae of galacturus eggs hatched in the laboratory were described.

The scales of coccogenis have the posterior margin broadly rounded to widely V-shaped, those of galacturus are deeply rounded to bluntly pointed, while those of rubricroceus are broadly shield shaped. Annuli were formed during the middle of April by individuals of galacturus, and in the last week of April by specimens of coccogenis and of rubricroceus.

Greatest growth occurred during the spring. Most individuals attained maturity when about two years old. They are short lived, and relatively few survive beyond the third summer.

Animal matter, large insects, was the principal food. (Auth. abst.)

947. Reed, Roger John. 1956. AN ECOLOGICAL STUDY OF THE ROSYFACE SHINER, NOTROPIS RUBELLUS (AGASSIZ) IN NORTHWESTERN PENNSYLVANIA. Dissertation Abstr., Vol. 16, No. 12, pp. 2565-2566.

This study was an attempt to investigate the ecology of the rosyface shiner, Notropis rubellus (Agassiz) in streams of the Ohio and Lake Erie drainages of northwestern Pennsylvania as shown by changes in the seasonal and daily behavior of rubellus, growth and numbers in the different age classes, yearly feeding habits, and their reproductive behavior.

Observations on the ecology of this species were made from June 17, 1953, until June 12, 1955. Specimens were collected from 12 streams of northwestern Pennsylvania, with the majority from French Creek and Slippery Rock Creek. Rubellus have a habitat preference during the spring, summer and fall for the basal portion of riffles. Their common riffle associates at this time are the bluntnose minnow, Hyborhynchus notatus (Rafinesque), hog nose sucker, Hypentelium nigricans (LeSueur) and the northern creek chub, Semotilus a. atromaculatus (Mitchill). There is a migration of rubellus into the deeper pools in November where

they remain until March.

The rosyface have a 5-week breeding period in this region. Spawning began May 26, 1954, in Slippery Rock Creek and continued until June 25th. The initial spawning date for 1955 was May 24th. The rosyface spawn over the stone nests built by the two Nocomis chubs only during the initial six days. After this, they utilize the gravel bottom of small riffles as a spawning site. Spawning is promiscuous, with the males and females massing together in small groups of 10 to 15 individuals. There is no nocturnal spawning of rubellus. The male undergoes a marked change in coloration prior to and during the breeding season.

Maturing eggs were found in female rubellus as early as February 19, 1954. The growth of the eggs was recorded until spawning occurred. The egg diameter sampled from gravid females on the first day of spawning was 1.5 millimeters. Rubellus eggs were fertilized in the laboratory and the various stages of their development recorded. At a mean water temperature of 61° Fahrenheit larvae hatched out 70 hours after fertilization. When the water temperature was controlled at 70° Fahrenheit larvae hatched out slightly over 58 hours. The larvae lose their yolk-sac by the fifth day after hatching. Scales and the lateral lines were present on rubellus fry 20-24 millimeters in standard length captured in late July.

The rosyface were omnivorous in their feeding behavior during the period of June 17, 1953, to June 9, 1954. The adults feed upon algae and diatoms (17.5 percent), insecta (74.4 percent) and inorganic material (9.1 percent). Caddis fly larvae were the most important insect eaten (25.1 percent). The number of empty stomachs for each of the 33 (50-specimen) samples were recorded and these figures were used as a criterion of seasonal activity. Feeding apparently stopped on November 19, 1953, and did not occur again until March 19, 1954. The young of the year were sampled and the stomach analysis showed a different feeding preference as compared to the adults during the same period. Algae and diatoms (65.0 percent) were eaten to a greater extent by the young than insect life (28.7 percent).

The life span of the rosyface is three years as determined by the scale reading method. The female rubellus attained the greatest mean growth during the three years (68.4 millimeters). The sex ratios for the age classes were: one-year class — 1146 males:978 females, second-year class — 393 males:375 females and the third-year class — 50 males:74 females. The total sex ratio was 1589 males:1427 females. The chi-square test showed that there is a significant departure from the 1 to 1 sex ratio in the first- and third-year class. In the second-year class there is no significant difference. (Auth. abst.)

948. Allen, George Herbert. 1957. MIGRATION, DISTRIBUTION, AND MOVEMENT OF PUGET SOUND SILVER SALMON. Dissertation Abstr., Vol. 16, No. 10, p. 1967.

The complexity of the migration, distribution, and homing instinct of silver salmon (Oncorhynchus kisutch), were demonstrated by the comparative behavior of five groups of marked fish of the 1950 brood planted during the spring of 1952 into Puget Sound streams. The salt-water distribution and migration were studied by the recovery of marked fish from the catch of 12 fisheries during 1952 and 1953. The fresh-water movements and homing were studied by the recovery of marked adult fish at hatchery traps and weirs.

Two groups, liberated into the Lake Washington drainage emptying into middle Puget Sound, were "mass-planted" as 12-month-reared fingerlings. One group was planted inland at the head of the Lake Washington system in Issaquah Creek; the second group was planted relatively near tidewater at the University of Washington, School of Fisheries. The three groups planted into Minter Creek, which empties into southern Puget Sound, were liberated relatively near tidewater. Two Minter Creek groups were released after 12 months of rearing; one was "scatter-planted" and the other "mass-planted." The third Minter Creek group was "mass-planted" during the peak of natural downstream migration of silver salmon in Minter Creek as 14-month-reared fingerlings.

The behavior of the five groups in fresh and salt-water varying with the time, place and age of fish at planting, resulted in differences in distribution, migration, exploitation, escapement, sex ratio, and time of arrival on the spawning grounds. Lake Washington fish had distinctly different behavior from Minter Creek fish. The two groups of Lake Washington fish had similar behavior, and the three groups of Minter Creek fish had relatively independent behavior. Some similarity in behavior was found for the 12-month, "mass-planted," Issaquah fish and the 14-month, "mass-planted," Minter Creek fish. The 12-month-reared, "mass-planted," Minter Creek group had behavior most closely resembling that of the Lake Washington groups.

Most fish from the Lake Washington drainage migrated outside of Puget Sound into the Pacific Ocean, and were exploited mainly by the ocean troll and Puget Sound commercial fisheries. Most Minter Creek fish remained inside Puget Sound and were caught mainly by the Puget Sound sport fishery. All fish remaining in Puget Sound were equally exploited by an intense sport fishery, although the distribution of the five groups was different. Exploitation of outside fish was unequal due to differences in distribution in the ocean and in migration in the ocean and through Puget Sound.

The percentage of marked fish accounted for in catch and escapement was equal for Lake Washington and Minter Creek fish (roughly 3.2 percent); however, the catch-to-escapement ratio was 10 to 1 for Lake Washington fish and 3 to 1 for Minter Creek fish. Approximately one fourth of the escapement to Lake Washington and Minter Creek was of inside fish, and three fourths of outside fish. A relatively large number of fish in the escapement of the 12-month-reared, "scatter-planted" Minter Creek group was the result of a high survival and of a relatively less intense exploitation of the outside fish

by the troll fishery.

Movement onto the spawning grounds was considered as either "appetitive" type of instinctive behavior of low order or a "consummatory" act. Movement of silver salmon into the hatchery ponds at the School of Fisheries was correlated with night-time rainfall. Movement of chinook salmon (O. tshawytscha) was correlated with sharply dropping barometric pressure. These studies of sexually mature fish were made under a condition which exhibited little fluctuation in water temperature, and no fluctuation in flow.

Lake Washington and Minter Creek fish were intermingled in middle Puget Sound during October. The only straying known was a single School of Fisheries mark recovered at Issaquah. Appearance on the spawning grounds did not occur until average water temperatures dropped below 50° F. Minter Creek and Issaquah fish arrived in peak numbers during late November, and School of Fisheries fish from mid-December until early January.

As the variable behavior between the five groups of marked fish resulted in differences in exploitation both within and between fisheries, different proportions of fish in the escapements, and unbalanced sex ratios, the difficulty to be expected in interpreting results from experiments involving only a few groups of marked fish was evident. Such variation in behavior can only be adequately evaluated by releasing numerous experimental groups and studying the recovery of marked individuals in fisheries which are adequately sampled.

The futility of extrapolating the results of investigations of a single sensory system to an explanation of the physiological and psychological mechanisms of the homing instinct was shown. The "appetitive" portion of the homing behavior in silver salmon, extending from migration from the ocean to fresh water, remains scantily described and unexplained. Since there is little knowledge of salt-water migration routes, any hypotheses on the mechanism involved in the ability of the salmon to retrace those routes must remain conjectural. (Auth. abst.)

949. Wiser, Cyrus Wymer. 1956. A COMPARATIVE LIMNOLOGICAL STUDY OF MARROWBONE AND RADNOR LAKES IN CENTRAL TENNESSEE. Dissertation Abstr., Vol. 16, No. 11, p. 2007.

A comparative study of Marrowbone and Radnor Lakes (artificial reservoirs) was made over a period of one year, from August 1952 to July 1953. The former lake is located approximately 6 miles south of Nashville in the Central Basin, while the latter is situated 12 miles northwest of the city on the dissected edge of the Highland Rim. Both are eutrophic, tropical lakes of the second order with medium hard water.

The physical factors which were studied included the geology of the drainage area, lake morphometry, and variations in color, turbidity, transparency and temperature. Chemical analyses were made for dissolved oxygen, free carbon dioxide, phenolpthalein and methyl orange alkalinities, hydrogen-ion concentration, nitrite and nitrate nitrogen, inorganic phosphates and sulfides. Monthly samples of net plankton and bottom organisms were taken from 15 different stations on the two lakes. Productivity estimates were based upon the mean annual standing crop in terms of numbers and areal standard units per liter in the case of plankton and numbers and biomass ("formalin weight") per square meter for the benthic fauna.

It was concluded that the greater production of phytoplankton in Marrowbone Lake was the result of greater shore line development, the greater percentage of the total water volume in the epilimnion during the summer, a higher nitrate content, less turbidity during phytoplankton pulses, and the addition of commercial fertilizer to the lake. The higher phosphate content of the water in Radnor enabled it to produce above-average amounts of plankton. The smaller angle of slope to the basin and the type of bottom materials seemed to be the controlling factors in the greater production of bottom organisms in Radnor Lake. (From author abstract).

950. Hagen, Harold Kolstoe. 1956. AGE, GROWTH AND REPRODUCTION OF THE MOUNTAIN WHITEFISH IN PHELPS LAKE, WYOMING. Dissertation Abstr., Vol. 16, No. 11, p. 2245.

The Rocky Mountain whitefish, Prosopium williamsoni (Girard), is an abundant and increasingly important game fish in many northwestern regions of the United States and in parts of Canada. Little is known about its life history, especially in lakes.

It was found in Phelps Lake, Wyoming, that the whitefish rarely occupied depths over 60 feet and usually ranged in depths between 15 and 60 feet. The diet of the fish was almost exclusively zooplankton during the summer months. There is a definite congregation of adult whitefish in the 20- to 40-foot depth zone with the approach of the spawning season. Little variation was found between growth or length of the female and male whitefish. A slight variation in weights at similar lengths of the two sexes was found. The Phelps Lake whitefish are first fully scaled at 40 millimeters fork length. The time of the new annulus formation was found to be either in late May or early June. The relationship of scale growth and body growth is not linear. The relationship of scale radius to any given length, however, is constant from year to year and between sexes. In Phelps Lake the whitefish rarely exceed 9 years of age. The whitefish of Phelps Lake grow more slowly and remain smaller than whitefish in adjacent streams and in some adjacent areas. It is possible that an interchange of fish occurs between the lake and the Snake River but no evidence of this was found. The adult whitefish show practically no growth after the middle of October until late in June. The influence of temperature is reflected in the increase in growth but this is probably an indirect reflection of an increased food supply. The heaviest proportionate natural mortality was indicated from ages Seven through Nine. The age of maturity for most Phelps Lake whitefish is in their third year after the formation of the second annulus. Whitefish with four annuli

were all found to be mature. The female whitefish mature later than the males. Two distinct rates of ova development were found. It was also found that both early and late maturing ova were spawned during the same season and not on alternate seasons. The late maturing ova were slightly smaller in diameter than the early maturing ova. Testes showed some evidence of variation in maturation. The number of eggs produced by the Phelps Lake whitefish average 7,757 per pound of fish and made up approximately 19 percent of the body weight just prior to spawning. The time of spawning in Phelps Lake is associated with temperature, but contrary to most reports the Phelps Lake whitefish started spawning on an increasing temperature. Spawning started in late September or early October and continued into November. Mountain whitefish spawn within the limits of Phelps Lake and do not attempt to enter the inlet or outlet although both are available to them. Young whitefish generally remain in the lake after hatching but were found to ascend the inlet stream a short distance. Whitefish spawned along many sections of the Phelps Lake shoreline. The erection of the pearl organs of the male seems to be directly associated with the spawning act and serves as an index to the time of actual spawning. (Auth. abst.)

951. Lowman, Frank George. 1956. THE STRUCTURE OF THE SPERMATOZOON OF THE SILVER SALMON, ONCORHYNCHUS KISUTCH (WALBAUM). Dissertation Abstr., Vol. 16, No. 11, p. 2247.

Sections and whole mounts of spermatozoa of silver salmon were investigated with the electron microscope. Standard techniques were used which are described in detail.

A historical review is given and the present observations are compared with those of other investigators.

The salmon spermatozoon is entirely covered by a membrane 80A in thickness and, in addition, is composed of (1) the head, containing the nucleus, nuclear membrane, mitochondrial granules, and a matrix; (2) the middle piece, composed of centrioles, mitochondrial granules, a tentatively identified Golgi remnant, and a matrix; and (3) the tail, consisting of the axial filament, mitochondrial granules, and a matrix.

In the tail the cell membrane is formed into two oppositely placed longitudinal folds, spirally wound five to seven times around the axial filament throughout its length of 28 to 35 microns.

The head is ovoidal with dimensions of about one and one-half by two microns. It is composed almost entirely of the nucleus covered by a 100A-thick nuclear membrane. In sections the nucleus is without visible internal structure and is of high density.

The mitochondrial granules, 300A to 2000A in diameter, surround the nucleus, are concentrated in the middle piece near the orign of the axial filament, and are distributed throughout the length of the tail in the lateral folds of the cell membrane.

The so-called Golgi remnant is comprised of osmiophilic material surrounded by a 100A-thick membrane. The membrane exhibits invaginations into the central material. Sections of the invaginations appear as irregular vesicles inside the Golgi remnant.

The centrioles are found in a deep depression of the nucleus on its posterior side. The proximal centriole is of two parts: an anterior hemisphere, 2700A in diameter and 300A thick, in contact with the bottom of the nuclear depression; and the posterior portion, which is cylindrical, 1800A in diameter, 700A long, lying inside and against the bottom of the hemispherical anterior portion. The distal centriole is cylindrical, 1500A in diameter, 1700A long, and abuts against the posterior proximal centriole. The peripheral fibrils of the axial filament originate at the anterior surface of the distal centriole and are embedded in its wall.

The axial filament extends the length of the tail and is comprised of 11 fibrils. Nine fibrils are 320A to 400A in diameter and form a tubiform structure about 1800A in diameter, in the center of which lie two smaller fibrils 220A to 300A in diameter. The configuration of nine peripheral and two central filbrils is found in the cilia and flagella of 51 genera, representing 8 phyla of plants and animals.

The nine peripheral fibrils of the salmon spermatozoon each contain five protofibrils of about 60A diameter. The two central fibrils each contain four protofibrils.

Salmon spermatozoa, when placed in hypotonic media, develop marked areas of swelling along the tail concurrently with cessation of motility, indicating the inability of the cell membrane to exclude water from the cell.

Although the tail increases in volume as much as 45 times in the areas of swelling, the axial filament retains its normal cross-sectional configuration. The stability of the axial filament, its fibrillar structure, the fact that it has the same cross-sectional pattern wherever found, and the observation in several species that the two central fibrils always lie on a line normal to the plane of motion, suggest that the axial filament is the contractile organ for motility. (Auth. abst.)

952. Parker, Richard Alan. 1956. A CONTRIBUTION TO THE POPULATION DYNAMICS AND HOMING BEHAVIOR OF NORTHERN WISCONSIN LAKE FISHES. Dissertation Abstr., Vol. 16, No. 11, pp. 2248-2249.

Flora Lake, a 102-acre body of water in Vilas County, Wisconsin, was the site of a 5-year program in which the density of fishes was reduced primarily with fyke nets in an attempt to increase the growth rates of important fish species. Annual quantities removed ranged up to 2,481 pounds (887 kg.), or 52.6 percent of the catchable standing crop at the time of the estimation of the population in early summer.

A second-degree polynomial was fitted to the data on calculated, total length at each year of life before 1952 as based upon scale-analyses. Moreover, appropriate confidence intervals about this pre-treatment growth curve were used to distinguish significant changes in the rate of growth from "normal" fluctuations. The covariance technique was employed to

test for a difference between adjusted, mean, logarithmic weights of specimens collected in 1952 and in 1956.

No important changes occurred in the linear growth rate of largemouth bass Micropterus salmoides; however, individuals were heavier, at a given length, in 1956 than in 1952. In addition, the total weight of bass over 5.1 inches (130 mm.) in length rose from 3.8 to 6.1 pounds per acre (4.3 to 6.8 kg./ha.), and the angling-yield increased from 34 pounds (15.4 kg.) in 1952 to 145 pounds (65.8 kg.) in 1955, although the effort remained nearly constant.

The 1953 and 1954 year classes of bluegills (Lepomis macrochirus), pumpkinseeds (Lepomis gibbosus), and hybrids of these two species responded favorably in linear growth rate, as did some year classes of rock bass (Ambloplites rupestris) and common white suckers (Catostomus commersonii). No change of this nature could be detected in the growth of golden shiners (Notemigonus crysoleucas); however, yellow perch (Perca flavescens) showed a marked decrease. Besides the largemouth bass, bluegills, pumpkinseeds, and suckers were "fatter" in 1956 than in 1952. No difference could be demonstrated for rock bass and hybrids, while perch and golden shiners were considerably "thinner".

Genetic background, differential rates of reduction during the experiment, and competition are discussed as possible reasons for the inconsistant effect on growth following a reduction in density of the population.

During the summer of 1955, largemouth bass from Flora Lake and Dadek Lake, and bluegills, pumpkinseeds, and bluegill x pumpkinseed hybrids from Flora Lake, were caught in fyke nets, marked as to area of initial capture, and displaced to a central point in order to investigate further the homing behavior of these centrarchids. Data on the numbers of fish marked at one station which were recaptured at any other station, and the shortest distance via water between stations as measured in 10-foot units, were utilized in a regression analysis which yielded a theoretical curve of the relative distribution of marked individuals with respect to their "home" territory. Further analyses confirmed the possible existence of two groups in the population, one that "homes" and one that moves about at random. The segment of recaptured individuals which "homed" was estimated to be approximately 31 percent of the bluegills, pumpkinseeds, and hybrids in Flora Lake, 18 percent of the bass in Flora Lake, and 25 percent of the bass in Dadek Lake; by chance alone, 8.6 percent, 10.2 percent, and 9.4 percent, respectively. Some aspects of the mechanisms which displaced fish may employ in returning to a preferred area are discussed. (Auth. abst.)

953. Seymour, Allyn Henry. 1956. EFFECTS OF TEMPERATURE UPON YOUNG CHINOOK SALMON. Dissertation Abstr., Vol. 16, No. 11, p. 2249.

During three experiments in successive years, temperature effects upon the chinook salmon, Oncorhynchus tshawytscha (Walbaum), from the egg to the fingerling stage have been observed. Observations included the effect of temperature upon the rate of embryological development, mortality, the occurrence of morphological abnormalities, growth rate, and the determination of the number of vertebrae, dorsal fin rays and anal fin rays.

For Experiment I eggs were obtained from one pair of Green River salmon and reared for 46 weeks in city water maintained at constant temperatures ranging from 34° to 65° F. Experiment II duplicated I except that the temperature range was 45° to 67½°F. and the experiment was terminated during the tenth week. For Experiment III chinook salmon eggs from the Green, Skagit, Entiat and Sacramento Rivers were used, the temperatures were altered throughout the experiment in a manner similar to that which occurs under natural conditions, well water replaced city water, and from one to four spawning pairs for each race were used. In all three experiments lots reared in the tap water as it was received at the hatchery were considered to be the controls.

The rate of development during incubation, at temperatures maintained at a constant level in the range from 40° to 58° F., was expressed adequately by either the temperature summation rule, the Belehradek equation, or an equation of the logistic curve. For all lots, regardless of temperature, mortality rate, race, or year the logistic curve was the best fit to the data. The temperature coefficients u, Q_{10} and x were not constant.

New estimates of the threshold temperature and its confidence interval, as well as an estimate of the temperature summation constant, are given. Threshold temperatures for the egg lots from the Sacramento River Salmon were highest, for the Entiat River, lowest, and for the Green and Skagit Rivers, intermediate. The same order prevailed for the rate of development.

A common pattern was observed for the relationship of temperature to the number of vertebrae, egg mortality, the number of abnormal fry and the duration of the hatching period. For lots reared at temperatures in the range from 40° to 58° the values were low but increased at both higher and lower temperatures.

The temperature at which the optimum growth rate occurred for fingerlings reared at constant temperatures was approximately 55° F. and for lots at city water temperatures, near 60° F. Taking into consideration both mortality and growth rate, the optimum temperature was about 52° F. for eggs and fry and 58° F. for fingerlings.

The minimum number of vertebrae and the maximum number of dorsal and anal rays were found to occur in the lots reared in the temperature range from 40° to 58° F. The range in number of vertebrae for the four races was 63 to 78, with practically no overlap in the number of vertebrae for chinook salmon of the Entiat and Sacramento races. Genotypical variation appeared to be greater than phenotypical.

Water of low oxygen during incubation increased

the number of vertebrae and the incubation period. (A)

954. Hayes, F. R. 1957. ON THE VARIATION IN BOTTOM FAUNA AND FISH YIELD IN RELATION TO TROPHIC LEVEL AND LAKE DIMENSIONS. J. Fish. Res. Bd. of Can., Vol. 14, No. 1, Jan., pp. 1-32.

The relation of area to depth was studied for 500 lakes. Up to 0.3 km.^{2} the mean depth is constant at 3 to 4 m. This is probably an artifact due to omission of shallow lakes from study. From 0.3 to 300 km.^{2} the relation of depth to area is linear on a log-log plot. In the largest lakes the depths increase less proportionally.

Of the three ways to study fish productivity in lakes, one, the estimate of standing crops, is usually attempted at mean depths around 1 m. Another, angling returns, centers on lakes of 3.5 m., while commercial reports come from lakes of 6.5 m. average depth, and extend to the deepest lakes

Fish records can be conveniently divided into three trophic levels, short food chain, e.g. carp, intermediate, e.g. bluegills and long, e.g. trout, bass. Records are interconvertible by use of factors. By factoring, a productivity index (P.I.) is calculated for some 150 lakes.

The productivity index is found to be inversely proportional to mean depth on a log-log plot. Thus by correction of the PI it is possible to derive a theoretical value, called the quality index (Q.I.), for a standard lake 5 m. deep.

The QI is intended to screen the effect of depth out of the PI and so disclose the inherent capacity of the lake. The QI values vary around unity. Lakes of mean depth under 2.5 m. are factored as of that depth, it being assumed that primary productivity due to photosynthesis goes on all the way to the bottom.

A study of bottom fauna in 250 lakes in several regions gave no indication of a relation between depth and productivity. (A)

955. Hobbs, Horton H., Jr. and Margaret Walton. 1957. THREE NEW CRAYFISHES FROM ALABAMA AND MISSISSIPPI. Tulane Studies in Zool., Vol. 5, No. 3, March 18, pp. 39-52.

Three new crayfishes of the Blandingii Group are described from Alabama and Mississippi. Procambarus hybus was collected from eight localities in Green County, Alabama; Kemper, Lowndes, and Noxubee Counties, Mississippi. P. mancus and P. jaculus are known from single localities in Lauderdale and Rankin Counties, Mississippi, respectively. All three of these crayfishes appear to be secondary burrowers, associated with temporary pools and roadside ditches. (Auth. abst.)

956. Hubbs, Clark. 1957. GAMBUSIA HETEROCHIR, A NEW POECILIID FISH FROM TEXAS, WITH AN ACCOUNT OF ITS HYBRIDIZATION WITH G. AFFINIS. Tulane Studies in Zool., Vol. 5, No. 1, March 18, pp. 3-16.

A new species of poeciliid fishes, Gambusia heterochir, restricted to the headwaters of Clear Creek, Menard County, Texas, is described. Both pectoral fins have a pronounced groove to steady the gonopodium during intromission. The new species has formed a hybrid swarm with Gambusia affinis. Introgression with G. heterochir appears negligible. Introgression is not found in neary-by populations of G. affinis. (Auth. abst.)

957. Bailey, Reeve M. and William A. Gosline. 1955. VARIATION AND SYSTEMATIC SIGNIFICANCE OF VERTEBRAL COUNTS IN THE AMERICAN FISHES OF THE FAMILY PERCIDAE. Misc. Pub. No. 93, Mus. of Zool, Univ. of Mich., Sept., 44 pp.

In an attempt to determine the value of vertebral number as a taxonomic character at specific, subgeneric, and generic levels in the Percidae, vertebrae were counted in some 5,413 specimens, representing 315 samples of 99 species of American percids. From this data it is concluded that there are certain average differences in vertebral number between genera and most subgenera and between many species within a subgenus. An analysis of these differences indicates vertebral number to be a powerful adjunct to phylogenetic interpretation, for in the American percids vertebral counts fit very well with a classification of these fishes established on the basis of other criteria.

In the matter of differentiating genera, subgenera, and species, however, the vertebral number is of limited use in darters because of the extensive overlapping in counts. A primary source of this overlap arises from the tremendous variation from sample to sample, even within subspecies. Preliminary experiments with darters show that (1) progenies from different parents of Etheostoma nigrum grown under the same environmental conditions can and do have different mean vertebral numbers, but also that (2) parts of progenies from the same parents grown at different temperatures differ in vertebral number. Thus, the differences in vertebral number between our samples from natural conditions may have been genetically or environmentally induced or both. By comparing aquarium specimens with hatchery and field data it is concluded that (1) very few wild parents would be necessary to provide the variability found in our wild samples, and that (2) selection operates in such a way as to cut down the amount of variability found within wild samples.

When samples within any one species are compared, there seems to be something of a southwest to northeast increase in vertebral number. Superimposed on this weak geographic gradient there is a more consistent trend within any one area for the fishes taken at higher altitude to have more vertebrae. Nevertheless, both of these gradients are insufficient to account for the local and geographic variations that occur in such a subspecies as Percina caprodes semifasciata.

As an attempt to find a more fundamental and consistent explanation for the variations that occur in samples of American percid species, it is hypothesized that it is the amount of change (warming) in

water temperature that occurs between spawning and the end of the sensitive period for vertebral formation that determines, at least in part, whether a sample will have a relatively high or low mean vertebral count. According to this hypothesis eggs laid in rapidly warming waters should have fewer vertebrae than genetically similar eggs spawned in more gradually warming waters. In lacustrine populations, thermal stratification may result in stimulation to breed at a given temperature with the resultant spawning occurring at a substantially different vertical and thermal level. Variations in spawning temperatures from lake to lake are reflected in average vertebral number, which is high when early development is in cool water, low if in warm water. Thus directional, altitudinal, and ecological gradients in vertebral numbers are all believed to result, at least in large part, from variations in temperature. (From author summary)

958. Hulburt, Edward M. 1957. THE DISTRIBUTION OF NEOMYSIS AMERICANA IN THE ESTUARY OF THE DELAWARE RIVER. Limnol. and Oceanography, Vol. 2, No. 1, Jan., pp. 1-11.

Observations on the planktonic shrimp, Neomysis americana (Smith), in the Delaware River estuary were carried out over a period of two years. It was found that Neomysis was far more abundant in the deep water of the estuary than in the near-surface or shallow water. Moreover, it was more abundant within the estuary than in the coastal waters at the mouth of Delaware Bay. Measurements of the length of the animal showed increase in size from the ocean toward the river end of the estuary. These features are interpreted in light of the probable circulation of the estuary to show that the animals became older during their "up-estuary" drift in deep water. Furthermore, they tended to accumulate within the estuary due to their avoidance of the out-flowing surface waters. A principal source for Neomysis in the coastal waters outside the Bay is thus suggested. During spring and summer, however, reproduction within the Bay contributed to the stock of animals there. The up-estuary extent of Neomysis was related to the 4 percent isohaline, and the partial exclusion from surface waters was attributed to their avoidance of excessive light. (Auth. abst.)

959. Gorham, Eville. 1957. THE CHEMICAL COMPOSITION OF LAKE WATERS IN HALIFAX COUNTY, NOVA SCOTIA. Limnol. and Oceanography, Vol. 2, No. 1, Jan., pp. 12-21.

Analyses for concentrations of total ions, Na, K, Ca, Mg, HCO_3, Cl, SO_4, and dissolved organic carbon, as well as optical density, pH, and specific conductivity, are presented for 23 surface lake waters collected from heathy spruce forest in Halifax County, Nova Scotia, during December 1955. As compared with the average fresh water of the world, these waters are very dilute, and proportionally low in calcium bicarbonate while high in sodium chloride. The three main factors governing chemical composition are shown to be (1) the nature of the geological substratum, (2) the influence of topography as expressed in the accumulation of mineral sediments and peat in and around the lake basins, and (3) proximity to the sea. (Auth. abst.)

960. Gorham, Eville. 1957. THE IONIC COMPOSITION OF SOME LOWLAND LAKE WATERS FROM CHESHIRE, ENGLAND. Limnol. and Oceanography, Vol. 2, No. 1, Jan., pp. 22-27.

Analyses are presented for the major dissolved constituents in waters from nine Cheshire meres. Calcium and bicarbonate ions predominate, but there are also large proportions of magnesium, sodium, sulphate, and chloride in these rather concentrated waters. The two lakes lacking inflow and outflow streams are chemically aberrant, and it appears that their ionic composition is greatly influenced by that of rain. The chemistry of the normal mere waters reflects the arid conditions in which the underlying Keuper marls were deposited. (Auth. abst.)

961. Boroughs, Howard, Sidney J. Townsley and Robert W. Hiatt. 1957. THE METABOLISM OF RADIONUCLIDES BY MARINE ORGANISMS. III. THE UPTAKE OF CALCIUM IN SOLUTION BY MARINE FISH. Limnol. and Oceanography, Vol. 2, No. 1, Jan., pp. 28-32.

To determine whether marine fish required calcium in their diet, or whether they could take up an adequate amount from sea water, non-feeding fish (Tilapia mossambrica) were put in artificial sea water with calcium^{45}. The uptake was rapid at first, then continued at a slow rate for the duration of the experiment (21 days). The normal concentration ratio of calcium by marine fish is about 20. At 21 days, the ratio of Ca^{45} in the fish to the Ca^{45} in an equal weight of sea water was about 0.6. The readily exchangeable calcium in the fish is therefore only a few percent of the total. The concentration ratio of 0.6 would seem to preclude the necessity of feeding captive marine fish calcium in order to have an adequate diet. The skeleton contained about 43 percent of the accumulated Ca^{45}, the integument 24 percent, the viscera 21 percent, the gills 8 percent, and the muscle 4 percent. The Sr/Ca ratio in marine fish as a whole is about 1:400, but the ratio in normal sea water is about 1:40. This means that marine fish discriminate against strontium either by excreting it faster or by absorbing it less. (Auth. abst.)

962. Starr, Theodore J. and Mary Elizabeth Jones. 1957. THE EFFECT OF COPPER ON THE GROWTH OF BACTERIA ISOLATED FROM MARINE ENVIRONMENTS. Limnol. and Oceanography, Vol. 2, No. 1, Jan., pp. 33-36.

The use of copper may prove feasible for the control of catastrophic fish mortalities associated with blooms of Gymnodinium brevis. Prerequisite is knowledge of the effect that relatively high concentrations of copper may have on the marine community as a whole. In this study the effect of copper on the growth of 145 marine bacteria was measured. All of the bacteria grew in a medium containing copper in concentrations up to 0.25 mg/L. This concentration was compared to the in vivo (0.2 mg/L) and in vitro (0.1 mg/L) lethal dose of

copper for G. brevis. In addition, the growth of approximately 4 percent of the bacteria was stimulated by this concentration of copper. (Auth. abst.)

963. Doty, Maxwell S. and Mikihiko Oguri. 1957. EVIDENCE FOR A PHOTOSYNTHETIC DAILY PERIODICITY. Limnol. and Oceanography, Vol. 2, No. 1, Jan., pp. 37-40.

It appears that there is a variation of around 5.7-fold in the ability of oceanic phytoplankton to photosynthetically fix carbon depending upon the time of day the productivity of fixed carbon is determined. The maximum photosynthetic ability appears to be during the few hours before mid-day, and the minimum ability around 1900 hours as determined by the carbon^{14} "light-dark bottle" technique. The original determinations were made in surface waters at surface temperature on three crossings of the equatorial region between about 110 and 140 degrees West Longitude. (Auth. abst.)

964. Erdman, Donald S. 1956. RECENT FISH RECORDS FROM PUERTO RICO. Reprint from Bull. of Mar. Sci. of the Gulf and Caribbean, Vol. 6, No. 4, Dec., pp. 315-340.

This paper brings up to date unpublished records of fishes from Puerto Rico. Distribution and abundance of 108 species are discussed. Interesting records are included of fishes which have been previously reported in the literature from Puerto Rico. Seasonal spawning records show periodicity. Several important fish species are marked by their absence in the waters in Puerto Rico. (Auth. abst.)

965. Bailey, Reeve M. 1956. A REVISED LIST OF THE FISHES OF IOWA WITH KEYS FOR IDENTIFICATION. Reprint from Iowa Fish and Fishing. Also, J. Paper No. J-2914 of the Iowa Agric. Exp. Sta., Ames, Iowa. 50 pp.

This list comprises 25 families, 56 genera, 133 species, and 136 total kinds, including subspecies, of native fishes. In addition, four exotic species, brown trout, rainbow trout, carp, and goldfish, have become established and are included in the list. Since 1951 one species (lake chub) has been added to the list and one, plains minnow, has been removed.

966. Zilliox, Robert G. and Martin Pfeiffer. 1956. RESTORATION OF BROOK TROUT FISHING IN A CHAIN OF CONNECTED WATERS. N. Y. Fish and Game J., Vol. 3, No. 2, July, pp. 167-190.

During the last half century, the introduction of yellow perch in Adirondack trout waters has caused a serious decline in the brook trout fishery. In return, these introductions have provided little, if any, angling, due to slow growth and stunting. The elimination of yellow perch from a chain of connected waters, forming the headwaters of the West Branch of the St. Regis River, was undertaken in the years 1952 to 1954. Fourteen ponds and 21.25 miles of inlets, outlets, main river and tributaries were treated with emulsifiable rotenone, 5 percent (Noxfish), at a concentration of approximately 0.5 ppm. More acre-feet of water per man-hour were generally treated in larger ponds than in smaller ponds. Complete kills are believed to have been obtained in some ponds; in others, all native species were not eradicated. Netting checks and angling returns up to and including 1956 indicate yellow perch were successfully removed.

Four barrier dams were constructed to prevent the reintroduction of undesirable species of fish into reclaimed waters.

Physical and chemical characteristics are presented for waters treated. Dissolved oxygen concentrations of less than 3.0 ppm. in the hypolimnion are considered an aid to reclamation. Toxicity tests, using live brook trout, indicated that most waters had lost their toxicity to this species within 30 to 50 days following treatment. However, an occasional body of water remained toxic for a much longer period.

Beaver activity is considered a severe hindrance to reclamation, particularly where beaver dams raise water levels over barrier dams or where flooding over a long period of time has created a floating bog environment. Also, unlocated springs, spring seepage areas, and aquatic mammal channels are believed to create escape zones for fish or late-spawned eggs. Such conditions are considered more likely to be responsible for failures experienced in eliminating certain species of native fish than the concentration of rotenone employed.

Growth and survival data indicated that, for other than initial hatchery plantings to provide immediate angling returns, there is little reason for stocking brook trout larger or older than fall fingerlings.

The study suggests that the reclamation of certain chains of water areas is feasible. Financially, such projects would be least expensive if they could be completed in one year. If the larger waters are located upstream in the chain, it is considered practical to treat them as a separate entity. Should treatment prove successful, then the smaller downstream waters can be treated later. (Auth. abst.)

967. Webster, Dwight A. 1956. MODIFICATIONS OF THE WOLF-TYPE FISH TRAP. N. Y. Fish and Game J., Vol. 3, No. 2, July, pp. 199-204.

An upstream trap is added to the Wolf trap by using a conventional V-type trap under the inclined screen of the Wolf trap. The usual functioning of the Wolf trap is modified by utilizing a core of water through the dam instead of the fall over the dam. Restraint of fish movement over the main spillway by means of racks or fences is necessary. (Auth. abst.)

968. Fischthal, Jacob H. 1956. OBSERVATIONS ON THE OCCURRENCE OF PARASITES IN THE FISHES OF CERTAIN SOUTH-CENTRAL NEW YORK STREAMS. N. Y. Fish and Game J., Vol. 3, No. 2, July, pp. 225-233.

In a survey of fish parasites during the summers of 1952 to 1954 from 10 streams of the Susquehanna River watershed of Broome and Tioga Counties, 448 fishes, representing 23 different species distributed in 6 families were examined and 385, or 85.9 percent were found to be infected with at least one species of parasite. The number infected with each parasite

as well as the relative intensity of infection is presented for each species of fish examined. A list of parasites giving the number of different species infected with each is also included. The larval forms of the parasites, most of which reach sexual maturity in fish-eating birds and mammals, occurred most frequently and in more species of fish than did the other developmental stages. The larval black grub and related larval strigeid parasites (Neascus spp.) were found in 20 species, the larval white grub (Posthodiplostomum minimum) in 15, various species of gill flukes (Gyrodactyloidea) in 15, and the nematode (Rhabdochona cascadilla) in 11. (Auth. abst.)

969. Pasko, Donald G. 1957. CARRY FALLS RESERVOIR INVESTIGATION. N. Y. Fish and Game J., Vol. 4, No. 1, Jan., pp. 1-31.

Studies were conducted during July and August in 1951 and 1955 to determine conditions in a 9-mile section of the Raquette River in St. Lawrence County before and after impoundment. The 3,200-acre impoundment, completed in 1953 under a Federal license and known as Carry Falls Reservoir, was for the purpose of storing and regulating the flow of water for the development of hydroelectric power downstream.

Fishermen from a wide area utilized the fish resource. Fishing pressure was light to moderate, although the total effort more than doubled following impoundment. Public use of the reservoir was encouraged by the power company, which provided access sites.

The quality of the fishing was mediocre before and after impoundment, except that bullhead fishing became quite good following a great increase in the bullhead population after impoundment. Smallmouth bass and northern pike were the principal game species present; the growth rate and rate of catch for these species showed little change. On the average, it required over 3 hours to catch a fish (all species combined) in 1951, and 3/4 hour in 1955. The total summer catch in 1955 was estimated to have increased over 20 times in number and 10 times in weight, the increase consisting mainly of bullheads.

It was found that natural spawning was adequate to maintain the population of fish of angling importance without additional stocking of hatchery fish.

The impoundment of the river resulted in gains in the over-all production and utilization of the fish resource, although some limitations probably resulted from the great fluctuation of water level which was necessary in operation of the reservoir. No harm to tributary trout waters was noted.

No changes in fishing regulations or other management methods were recommended. (Auth. abst.)

970. Rathjen, Warren F. and Lewis C. Miller. 1957. ASPECTS OF THE EARLY LIFE HISTORY OF THE STRIPED BASS (ROCCUS SAXATILIS) IN THE HUDSON RIVER. N. Y. Fish and Game J., Vol. 4, No. 1, Jan., pp. 43-60.

The spawning grounds of the striped bass in the Hudson River in 1955 were found to include the area from Bear Mountain upriver to Cruger Island. On the basis of evidence collected, the most intense spawning took place in the vicinity of West Point in essentially fresh water. Striped bass eggs were found from mid-May through mid-June. The distribution and growth of young striped bass in the Hudson is described. The brackish portion which includes the area from Newburg south to the George Washington Bridge was found to be the most important nursery ground. (Auth. abst.)

971. Hatch, Richard W. 1957. SUCCESS OF NATURAL SPAWNING OF RAINBOW TROUT IN THE FINGER LAKES REGION OF NEW YORK. N. Y. Fish and Game J., Vol. 4, No. 1, Jan., pp. 69-87.

The efficiency of natural spawning in three Finger Lakes tributaries supporting natural spawning runs was measured by redd sampling. Forty-five redds were excavated when eggs were at the eyed stage. The mean pre-eyed loss was 11 percent, the median 8 percent. Only three redds had losses greater than 25 percent. Nonfertilization accounted for 2 percent of the losses. No correlation was found between pre-eyed losses and the amount of fine material (silt and clay) within the redd. The amount of fine material exceeded 1 percent (by weight) in only one redd. (Auth. abst.)

972. Burdick, G. E., Howard J. Dean and Earl J. Harris. 1957. LETHAL OXYGEN CONCENTRATIONS FOR YELLOW PERCH. N. Y. Fish and Game J., Vol. 4, No. 1, Jan., pp. 92-101.

The curve for the mean oxygen concentrations lethal to yellow perch over short exposure periods has been constructed for a temperature range from 53.3° to 70.0° F. An equation has been formulated to fit the data as plotted on semi-logarithmic paper. The procedure involves the gradual reduction of the oxygen content of water in a sealed container through respiration of the enclosed fish. Complete loss of equilibrium is used as the endpoint. The oxygen concentration at the endpoint corresponds closely to the lethal concentration for short exposures. Conditions to which the fish are exposed under this method approximate those resulting from intermittent discharges of organic, oxygen-demanding wastes into polluted streams more closely than do conditions produced by other methods which have been used to evaluate the tolerance of fishes to low oxygen concentrations. It is believed these data may be directly applied to such situations. (Auth. abst.)

973. Burdick, George E. 1957. A GRAPHICAL METHOD FOR DERIVING THRESHOLD VALUES OF TOXICITY AND THE EQUATION OF THE TOXICITY CURVE. N. Y. Fish and Game J., Vol. 4, No. 1, Jan., pp. 102-108.

A hypothesis is set up that the curvature found in logarithmic plots of concentration against time for death in toxicity studies is induced by failure of the effective range to conform to the axes of the paper. Translation may be effected by subtracting the threshold value from concentration and a minimum

time for death from time. When this is done the curve becomes a straight line and represents a simple inverse proportion.

A graphical method is presented by which these correctives may be approximated and an equation for the original curve derived.

The major usefulness, other than providing a simple method of obtaining the equation of the curve, lies in the evaluation of the threshold concentration which can be used to establish safe disposal rates for toxic wastes. (Auth. abst.)

974. Loeb, Howard A. 1957. NIGHT COLLECTION OF FISH WITH ELECTRICITY. N. Y. Fish and Game J., Vol. 4, No. 1, Jan., pp. 109-118.

The populations of carp, yellow perch, and smallmouth bass in East Masonville Lake (30 acres) were estimated with the aid of an electric surface device which has been described in detail (Loeb, 1955). Briefly, it consisted of four 7-foot electrodes suspended from a wooden scow and powered by a 230-volt alternating-current generator.

Daylight operations were found to be effective only under special circumstances. However, the number of fish collected at night with the aid of spotlights was greater than expected. Accordingly, electrical techniques for night operation were developed and then used successfully in Lamoka and Waneta Lakes. Fish were also successfully collected from Hyde Lake. The device failed in Onondaga Lake because of the low water resistivity. (Auth. abst.)

975. Black, Edgar C. 1957. ALTERATIONS IN THE BLOOD LEVEL OF LACTIC ACID IN CERTAIN SALMONOID FISHES FOLLOWING MUSCULAR ACTIVITY. (I. Kamloops Trout, Salmo gairdneri). J. Fish. Res. Bd. Can., Vol. 14, No. 2, March, pp. 117-134.

During the summers of 1953, 1954 and 1955, experiments were carried out on the effects of muscular exercise on hatchery-raised yearling and two-year-old kamloops trout, Salmo gairdneri, at the Summerland Trout Hatchery, Summerland, B. C. Following 15 minutes of vigorous exercise at 11.5° C. the blood level of lactic acid in yearlings increased from the unexercised level of 16 mg.% to 100 mg% and then continued to increase still further during the first 2 hours of recovery to 170 mg.% to subside in 4 to 6 hours toward the pre-exercise level. Similar changes occurred in two-year-olds, but the levels were lower in all cases, and the time course was slower. Studies were also made on hemoglobin levels, on blood glucose changes in two-year-olds, and on the relation of oxygen levels and temperature to the blood levels of lactic acid in yearlings. Cardiac rates were also measured. Observations were made on the blood level of lactic acid in moderate exercise in yearlings. The results indicate that most of the features of fatigue in the trout are in keeping with the pattern of changes in mammals. However, there were important differences in the time course of rise and fall of lactic acid to and from the blood. It is suggested that these differences may be due to the effects of lowered temperature in reducing the rate of diffusion of lactic acid between extracellular fluids and the sites of production and removal of the metabolites of muscular activity. Some implications of the results to the behaviour of fishes and death due to over-exertion are discussed. (Auth. abst.)

976. Blair, A. A. 1957. SALMON TAGGING AT FRANCIS HARBOUR BIGHT, LABRADOR. J. Fish. Res. Bd. Can., Vol. 14, No. 2, March, pp. 135-140.

Francis Harbour Bight, situated near the southern end of the Labrador coast, was the centre of tagging operations in 1950. During the period June 28 to July 18, 74 salmon and 41 grilse caught in comercial gear were tagged. In this area the salmon run extends from June 10 to July 31 with the peak around June 30, and the time of the grilse run is from July 1 to August 15 with the peak around July 20. Thus the tagging period covered the last half of the salmon run and the first part of the grilse run.

There was a 15 percent return of tagged salmon which is considered to be fairly representative. All the recaptured salmon were taken in Labrador by commercial gear. The distribution north and south of the tagging area was equal and extended to the northernmost limit of the commercial salmon fishery. The greatest distance travelled by a recaptured salmon was 186 miles, and the fastest rate of travel was 17 miles per day.

The small return of tagged grilse of just over 7 percent is indicative of low fishing effort. The fishermen here are mainly concerned with procuring the larger salmon and in prosecuting the cod fishery. (Auth. abst.)

977. Blair, A. A. 1957. SALMON TAGGING AT CAPE CHARLES, LABRADOR. J. Fish. Res. Bd. Can., Vol. 14, No. 2, March, 141-144.

Salmon from the commercial fishery at Cape Charles, southern Labrador, were tagged in 1948. During the short tagging period of June 30 to July 10, 35 salmon and 24 grilse were tagged. Due to delays in reaching Labrador the peak of the salmon run was missed, and it was difficult to get salmon in good condition for tagging because of storms. Salmon returns consisted of five taken in commercial gear in Labrador and one angled in a west coast Newfoundland river, giving a total recovery of 17.1 percent. Only two, or 8.3 percent, of the tagged grilse were recaptured, both being caught in commercial gear in Labrador. (Auth. abst.)

978. Greenbank, John. 1956. MOVEMENT OF FISH UNDER THE ICE. Copeia, No. 3, Aug. 29, pp. 158-162.

Two trap nets with webbing to form a complete barricade were placed under the ice in the outlet to Target Lake, a backwater of the Mississippi River. During the 40 days of winter these traps were operated, 3,328 fish were taken. Over 80 percent consisted of black crappie, yellow bullhead, and bowfin.

Catch numbers varied greatly but with definite trends. Extremely good positive correlation was obtained between total fish movement and the amount of snow cover on the ice. Data are in-

sufficient to establish absolute proof statistically of a causal relationship between light reduction caused by snow cover and fish movement, but with current, water temperature, and dissolved oxygen largely ruled out as influencing factors in this study the causal relationship is strongly suggested. Physiological and psychological relationships involved are not clearly understood.

979. Godfrey, Harold. 1957. MORTALITIES AMONG DEVELOPING TROUT AND SALMON OVA FOLLOWING SHOCK BY DIRECT-CURRENT ELECTRICAL FISHING GEAR. J. Fish. Res. Bd. Can., Vol. 14, No. 2, March, pp. 153-164.

Two units of direct-current fishing gear, providing terminal potentials of 550 and 150 volts, were used to give shocks of different severities to trout and salmon ova in various stages of development. The purpose of the tests was to establish precautionary measures to prevent damaging eggs when using similar apparatus, in waters of similar conductivity, in the vicinity of natural redds containing live eggs. High terminal voltage caused heavy losses among pre-eyed eggs, considerably fewer losses among eyed eggs, and no losses to eggs that were near hatching. There were no losses among eyed or pre-eyed eggs with low terminal voltage. Eggs that had been buried in the gravel of a stream apparently received some protection from electric shock. Salmon alevins were killed by prolonged severe shock, but not by a similar shock of shorter duration. The alevins showed greatly increased activity and swam about sporadically when in the electric field, but did not exhibit galvanotropic responses of a directional character. (Auth. abst.)

980. Vernon, E. H and R. G. McMynn. 1957. SCALE CHARACTERISTICS OF YEARLING COASTAL CUTTHROAT AND STEELHEAD TROUT. J. Fish. Res. Bd. Can., Vol. 14, No. 2, March, pp. 203-212.

Some scale characteristics of 88 yearling coastal cutthroat trout (Salmo clarki clarki) and 96 yearling steelhead (Salmo gairdneri) were compared in some detail. Although the number of diagonal scale rows above the lateral line was significantly higher in cutthroat, the counts of the two species overlap. The correlation of scale circuli counts with scale diameter was 0.94 for steelhead and 0.90 for cutthroat. At any given scale size cutthroat had 8 percent more circuli than steelhead scales. Measurements of lateral and longitudinal diameters and anterior radii of scales show that the anterior portions of cutthroat scales tend to be longer and narrower than those of steelhead.

Regression analyses of each scale measurement on fork length indicated that, for any given fork length, cutthroat scales are smaller than those of steelhead; the greatest difference being apparent when anterior radii are compared. Growth of scales in a dorsoventral plane approximates isauxesis in relation to fork length but scale growth in a longitudinal plane tends toward positive heterauxesis which is particularly pronounced in the anterior portions of scales.

Multiple regression analyses of scale diameter, scale row count and fork length indicated that the smaller size of cutthroat scales is not balanced by proportionate increase in their number. When scale diameter is adjusted for scale number and fork length, cutthroat scales are 15.6 percent smaller than those of steelhead, indicating that young cutthroat are covered by their scales with less overlap. (Auth. abst.)

981. Tunison, A. V. 1957. METHODS FOR DETERMINING THE EFFICIENCY OF PRODUCTION IN THE TROUT HATCHERY. Prog. Fish-Cult., Vol. 19, No. 2, pp. 51-57.

Criteria by which the efficiency of trout-producing hatcheries may be evaluated are essential to optimum management. Annual production in pounds; size of hatchery; production potentials such as management-program needs, water supply, rearing facilities, disease epidemics or other losses, and availability of operating funds; production per man-year of labor; feed conversion and food cost of production; distribution factors; utilization of funds for fish production, maintenance, and operations; and the cost per pound of trout are major factors to be considered in determining the value of trout hatcheries. (Auth. abst.)

982. Allison, Ray. 1957. SOME NEW RESULTS IN THE TREATMENT OF PONDS TO CONTROL SOME EXTERNAL PARASITES OF FISH. Prog. Fish-Cult., Vol. 19, No. 2, April, pp. 58-63.

Concentrations of 5, 10, and 15 ppm. formalin in aquaria averaged between 92 and 99 percent control of Gyrodactylus and between 55 and 98 percent control of Trichodina on speckled bullheads (Ameiurus nebulosus marmoratus); potassium permanganate, in concentrations of 2, 3, and 4 ppm. in aquaria, averaged between 96 and 99 percent control of Gyrodactylus and between 77 and 99 percent control of Trichodina. In ponds containing speckled bullheads, 5.5 ppm. formalin gave complete control of Gyrodactylus and 3 ppm. potassium permanganate gave satisfactory control of Trichodina. Formalin at a concentration of 15 ppm. gave partial control of Ichthyophthirius multifiliis on bluegill (Lepomis macrochirus). (Auth. abst.)

983. Wood, E. M., W. T. Yasutake and H. E. Johnson. 1957. ACUTE SULFAMETHAZINE TOXICITY IN YOUNG SALMON. Prog. Fish-Cult., Vol. 19, No. 2, April, pp. 64-67.

Increased mortalities, tissue damage, and renal sulfonamide crystals were observed in young silver salmon (Oncorhynchus kisutch) after a single day's treatment for an acute psuedomonad infection. An attempt was made to reproduce the condition experimentally by feeding sulfamethazine at high levels. Similar pathology was observed, but precipitation of sulfamethazine in the kidney did not occur. (Auth. abst.)

984. Anonymous. 1957. EFFECTS OF JAW TAGS OBSERVED UNDER HATCHERY CONDITIONS. The Prog. Fish-Cult., Vol. 19, No. 2, April, p. 67.

The effects of monel jaw-tags on rainbow trout were observed during a 9.5-month period. Two lots of 1,000 6-inch fish were used, one acting as a control. The growth rates were very similar indicating that the tags did not inhibit active feeding or retard growth.

985. Phillips, Arthur M., Jr. and Henry A. Podoliak. 1957. THE NUTRITION OF TROUT: III. FATS AND MINERALS. Prog. Fish-Cult., Vol. 19, No. 2, April, pp. 68-75.

A summary article in which the fat and mineral requirements of the higher animals are discussed and these requirements are compared with those of trout. (Auth. abst.)

986. Burrows, R. E. 1957. ACCELERATION OF SPAWNING OF ADULT SALMON. The Prog. Fish-Cult., Vol. 19, No. 2, April, p. 75.

Blueback salmon exposed to continuous light for a 2-month period prior to normal spawning time spawned one month later than a control group. Conversely, adult blueback salmon exposed to only 9.25 hours of artificial light per day spawned 19 days earlier than a control group. Though analysis of data is not yet complete, eggs from salmon induced to spawn early appear normal though slightly smaller than those of control fish.

987. Newell, Arthur E. 1957. TWO-YEAR STUDY OF MOVEMENTS OF STOCKED BROOK TROUT AND RAINBOW TROUT IN A MOUNTAIN TROUT STREAM. The Prog. Fish-Cult., Vol. 19, No. 2, April, pp. 76-80.

In 1953, data were collected by creel census on 781 jaw-tagged brook trout and 358 rainbow trout, and in 1955 this information was obtained for 302 brook trout and 203 rainbow trout. With the exception of fish stocked in May and the one planting of brook trout in June 1953, most of the trout were recaptured in the immediate vicinity of their release. In all plantings brook trout exhibited a greater tendency to move than did rainbow trout. Of those fish recaptured in areas other than the planting site, most had moved downstream and most had moved less than 3/4 of a mile. All May stockings showed a greater tendency toward movement than the June and August stockings when the water had warmed considerably. No correlation between water level and fish movement could be found.

988. Snieszko, S. F. 1957. USE OF ANTIBIOTICS IN THE DIET OF SALMONID FISHES. The Prog. Fish-Cult., Vol. 19, No. 2, April, pp. 81-84.

Without exception, addition of antibiotics to the diet of fingerlings has no significant effect on their growth rate. This contrasts with results obtained with higher vertebrates, e.g., chickens, young pigs, and calves, for which an increased growth rate has been noted. The beneficial effect in higher vertebrates results from the destruction of intestinal flora, some of the micro-organisms being beneficial, others competing with the host for food or being actually harmful to the host. Intestines of healthy fish when free of food are nearly sterile; thus, the absence of any beneficial effect on growth rate of antibiotics in their diet. Available information on this subject, including authors, species of fish tested, nature of diet additive, and results, is presented in a summary table.

989. Grassl, Edward F. 1957. POSSIBLE VALUE OF CONTINUOUS FEEDING OF MEDICATED DIETS TO PREVENT AND CONTROL PATHOGENS IN HATCHERY-REARED TROUT. Prog. Fish-Cult., Vol. 19, No. 2, April, pp. 85-88.

It was thought that instead of constantly increasing dosages of sulfa drugs to treat furunculosis, continuous feeding of mild medicaments might effect the desired control of the disease. To test this hypothesis, it was necessary to select a drug which could be used continuously without an adverse effect on the trout. Antibiotics had the physical and chemical qualifications necessary. An opportunity to test the disease-prevention properties of aureomycin was presented on September 3, 1955, when furunculosis appeared as a natural infection at the Wolf Lake Hatchery. Immediately upon detection of the disease, the trout were counted. Half of the 212 trout received the medicated diet; the other half, non-medicated food. The medicated diet contained aureomycin at the rate of 200 grams per ton of feed. Pelleted food was given to these groups of trout at the rate of 1.7 percent of body weight per day. Between September 3, 1955, and February 29, 1956, survival amounted to 21 percent among the fish receiving the non-medicated diet and 57 percent among those receiving the medicated diet. Aureomycin apparently contributed to the well-being of the fish afflicted with furunculosis. These data are based on a single experiment involving two groups of animals and must be regarded as preliminary. (W.R.C.)

990. Hatch, Richard W. 1957. RELATIVE SENSITIVITY OF SALMONIDS TO DDT. Prog. Fish-Cult., Vol. 19, No. 2, April, pp. 89-91.

Fingerling landlocked salmon (Salmo salar), brook trout (Salvelinus fontinalis), and rainbow trout (Salmo gairdneri) were subjected to DDT in concentrations of 0.08 to 10.00 ppm. at near maximum temperatures in unaerated aquaria. Hatchery-reared progeny of wild adults were used. Salmon were killed, without loss of brook trout, in 36 hours at concentrations less than 0.32 ppm. At higher concentrations, all species showed at least 50 percent mortality in 36 hours. The LD_{50} for all species was between 0.08 and 0.16 ppm. with aeration. Landlocked salmon appeared more sensitive to DDT than the other two species. (Auth. abst.)

991. Anonymous. 1957. STUDIES ON TILAPIA IN TAIWAN. The Prog. Fish-Cult., Vol. 19, No. 2, April, p. 91.

Studies to develop a variety of Tilapia better adapted to the climatic conditions of Taiwan have shown that temperatures of 40° C. and above and 3° C. and below resulted in dead sperm within 2 hours, that a pH of 5.4 is most suitable for sperm though a

pH of 4.2 to 6.8 permitted sperm to live for 4 to 5 hours, that the specific gravity of a Tilapia egg is 1.080 to 1.095, and that the eggs require a good supply of oxygen, those placed in jars that received merely frequent changes of water failing to hatch.

992. Carlander, Kenneth D. and Robert B. Moorman. 1957. SOME EXPERIMENTS IN CHANGING POPULATION BALANCE IN FARM PONDS. The Prog. Fish-Cult., Vol. 19, No. 2, April, pp. 92-94.

Comparison of the results of the Swingle method and the population study method of determining population balance in 60 ponds revealed that the latter method made apparent some situations not indicated by minnow-seine inspection. The two methods resulted in different classifications of 13 ponds; 4 of these ponds which were found to be in balance by the minnow-seine method winter-killed prior to the population study. Both methods were in agreement that the same 18 ponds were in balance, the Swingle method indicated 22 and the population study method 27.

Most attempts to bring ponds back into effective production by supplemental stocking with bass and bluegills failed. It is concluded that such attempts are not likely to succeed in ponds that tend to be at a low level during the winter or that have a history of winter-kill.

993. Chapman, Donald W. 1957. USE OF LATEX INJECTIONS TO MARK JUVENILE STEELHEAD. The Prog. Fish-Cult., Vol. 19, No. 2, April, pp. 95-96.

Colored liquid latex injected by syringe under the white ventral skin of young steelhead trout was plainly visible 8 weeks later. No differential mortality between tattooed and latex-injected fish was observed. The most satisfactory mark was produced by inserting the needle into the anus and forcing the point through the intestinal wall toward the ventral fins until it was plainly visible beneath the skin.

994. Combs, B. D and R. E. Burrows. 1957. THRESHOLD TEMPERATURES FOR THE NORMAL DEVELOPMENT OF CHINOOK SALMON EGGS. Prog. Fish-Cult., Vol. 19, No. 1, Jan., pp. 3-6.

The threshold temperatures for normal development were determined by incubating chinook salmon (Oncorhynchus tshawytscha) eggs at constant water temperatures ranging from 35° to 60° F. Mortality was the criterion used for determining normal development. Mortalities resulting from eggs incubated at temperatures above 57.5° and below 42.5° F. were determined statistically to be significantly higher than mortalities resulting from intermediate incubating temperatures. The upper threshold temperature was established at 57.5° F. and the lower at 42.5° F. (Auth. abst.)

995. Wood, E. M. and W. T. Yasutake. 1957. HISTOPATHOLOGY OF FISH. V. GILL DISEASE. Prog. Fish-Cult., Vol. 19, No. 1, Jan., pp. 7-13.

The histopathology of gill disease is described. Morphological differences between bacterial gill disease and nutritional (pantothenic acid-deficient) gill disease are observed. Typical myxobacteria and other bacterial forms are observed in mixed and in apparently pure states as the causative agents of the bacterial lesions. An entity termed "hemorrhagic" gill disease is also described. (Auth. abst.)

996. Wolf, Ken. 1957. BLUE-SAC DISEASE INVESTIGATIONS: MICROBIOLOGY AND LABORATORY INDUCTION. Prog. Fish-Cult., Vol. 19, No. 1, Jan., pp. 14-18.

Bacteriological examinations and cultures, methods of tissue culture, and repeated attempts at transmission were studied in an investigation of blue-sac disease of fish sac-fry. The results did not indicate an infectious nature. The disease was induced by incubating eggs at 13° C. in a closed system, and longer periods generally resulted in higher incidences. High levels of ammonia were found in units having high percentages of diseased fry. The percentage of diseased fry was much lower in replicates which employed filters of activated charcoal. The disease was induced by adding ammonia and urea to water which flowed over eggs during incubation. The primary cause of the disease is postulated to be an ineffective removal of metabolic wastes. Effective control of the disease consists in prevention. This can be accomplished by maintaining an effective water flow past the eggs. Accumulation of debris, fungus, and other obstructions to water flow should be prevented. (Auth. abst.)

997. Phillips, A. M., Jr., D. R. Brockway, F. E. Lovelace and H. A. Podoliak. 1957. A CHEMICAL COMPARISON OF HATCHERY AND WILD BROOK TROUT. Prog. Fish-Cult., Vol. 19, No. 1, Jan., pp. 19-25.

A chemical comparison of hatchery and wild brook trout indicated that wild trout were superior to hatchery trout. More true flesh production (ash and protein) was found in the bodies of wild trout than in those of hatchery trout. A comparison of protein conversions of the two types of food suggested that natural food was more efficient than hatchery food in producing fish flesh. The protein conversion for hatchery food was twice that for natural food. (Auth. abst.)

998. Johnson, Leon D. 1957. NEUTRALIZING ELECTROSTATIC CHARGE ON ROLLING-MILL SCALE PRESS. Prog. Fish-Cult., Vol. 19, No. 1, Jan., p. 31.

This note describes the installation of radioactive lens brushes (obtainable at any photographic store) on a rolling-mill scale press to prevent the difficulties encountered in preparing slides when the press, scales, and slides become electrostatically charged.

999. Parkhurst, Z. E. and M. A. Smith. 1957. VARIOUS DRUGS AS AIDS IN SPAWNING RAINBOW TROUT. The Prog. Fish-Cult., Vol. 19, No. 1, Jan., p. 39.

Five drugs — sodium amytal, tricaine methane-

sulfonate (M.S. 222), methyl pentynol, urethane, and chloretone — were tested for anesthetizing trout. In each trial, one of the drugs was used in spawning 12 female and 8 male rainbow trout; a similar control lot was spawned without use of a drug. Water temperature was 43° F.

Sodium amytal, because of its slow action, had no practical value. Tricaine methanesulfonate completely anesthetized fish in 30-45 seconds at a concentration of 264 ppm.; some mortality resulted from longer exposures. Methyl pentynol acted in 3.5 mintes at a concentration of 2,400 ppm. and no ill effects resulted from slightly longer exposures. Urethane anesthetized trout for spawning in 2 minutes at a concentration of about 5,000 ppm. Chloretone at 400 ppm. had trout partly anesthetized in 1 to 1.5 minutes. There was no evidence of harmful effects of any of the drugs on adults or eggs.

1000. Hublou, Wallace F. 1957. A METHOD OF USING AN ANESTHETIC IN MARKING FINS. The Prog. Fish-Cult., Vol. 19, No. 1, Jan., pp. 40-43.

Use of an anesthetic in a closed recirculating system was found to be a safe and desirable procedure in the fin-marking of fingerling salmon and steelhead trout. An over-all improvement in marking rate of 49.5 percent resulted from employment of this procedure. With anesthetic, 1,381,230 fish were marked in 3,109 hours averaging 444 per hour, while without anesthetic it required 9,299 hours to mark 2,760,659 fish for an average of 297 per hour. In addition to improved speed in marking, several other advantages are that the marks are better, the fish are less likely to be injured, the marker's fatigue is reduced, and individual length and weight samples are relatively easy to obtain.

1001. Bachmann, Roger W. 1957. PROFESSIONALISM IN FISHERY BIOLOGY. The Prog. Fish-Cult., Vol. 19, No. 1, Jan., pp. 44-46.

A questionnaire survey of the fishery departments of the 48 States was conducted in 1953 to determine the opportunity for fishery scientists to provide private consulting services. The conclusions reached are: (1) that there is a need for professional fishery biologists who can give aid and advice to private-pond owners, (2) that in most areas a private consulting service would be welcomed by the state agencies concerned with fishery management, and (3) that the extent to which a service of this type would be profitable depends on the area concerned, the greatest opportunities lying in the eastern and southern portions of the United States.

1002. Wilson, William D. 1956. NOTES ON CESTODES IN PADDLEFISH, POLYODON SPATHULA (WALBAUM), FROM THE MISSOURI RIVER. Reprint from the Trans. of the Kans. Acad. of Sci., Vol. 59, No. 4, pp. 459-460.

Four fish were inspected and were found to be heavily parasitized with cestodes Marsipometra hastata, M. parva, and M. confusa. Most were located in the pyloric caeca and spiral valve, a few in the stomach. Other parasites observed but not identified are two kinds of monogenetic trematodes from gill filaments; nematodes from cysts in the wall of the stomach, pyloric caeca, and spiral valve; and two nematodes from the anal region of one paddlefish. Probably accidental cutting of the intestine during dressing or a large number of migrating cestodes, or both, accounts for reports of heavily parasitized flesh of paddlefish.

1003. Greer, J. K. and Frank B. Cross. 1956. FISHES OF EL DORADO CITY LAKE, BUTLER COUNTY, KANSAS. Reprint from Trans. of the Kans. Acad. of Sci., Vol. 59, No. 3, pp. 358-363.

This lake, an impoundment with a capacity of 3,000 acre-feet and a surface of 265 acres, is located on Satchel Creek. The impoundment filled in 1928 and provided excellent fishing for a few years, sporadic good fishing thereafter, but unsatisfactory fishing in recent years. Rehabilitation was undertaken during a period of low water levels in 1954. Commercial fishermen harvested 60,000 pounds of buffalo and carp, and 6,000 channel catfish and 50 largemouth bass were salvaged by the State Fish and Game Department. Remaining fish were rotenoned.

Though data are not precise, it is probable that the standing crop exceeded 400 pounds per acre with the reservoir filled to capacity. The numerical ratios at the time of poisoning of two sport fish to one other fish and one sport fish of acceptable size to 19 other fish may not accurately reflect conditions in years immediately preceeding the rehabilitation. Commercial removal of carp and buffalo, the salvaging of channel catfish and bass, reduction of spawning success and unusually effective predation with receeding water levels, and possible bias of the random sample taken following rotenoning, all influenced these ratios. From the standpoint of fishing, however, the ratio was unfavorable.

Age and growth information for the major species is included.

1004. Morris, Robert W. 1956. SOME ASPECTS OF THE PROBLEM OF REARING MARINE FISHES. Bull. of L'Institut Oceanographique, Monaco, No. 1082, July 25, 61 pp.

As great a variety of eggs and larvae as possible were studied and their natural ecology with the ease (or, more properly, the difficulty) with which they are reared in the laboratory was compared. It is seen that the more intimate their association with a particular water mass, the more difficult they are to rear.

Eggs studied in this investigation were from three sources: naturally spawned, spawned in the laboratory, and artificially stripped. The mechanics of incubating different types of eggs are dictated by the manner in which they are spawned and incubated in nature. The degree to which it is possible to control conditions of incubation depends to a large extent upon the methods by which the eggs are collected. Use of eggs collected from natural spawnings is of uncertain value, since the characteristics

of their earlier environment are unknown. Control of conditions during field collecting operations is extremely difficult. Upon hatching, enzymatic activity may cause difficulties if it is not given proper consideration. Care must be taken to prevent formation of gas bubbles in the water, since they become attached to the larvae and incapacitate them.

Generally speaking, the larvae of marine fishes are pelagic organisms not adapted for survival in the proximity of solid surfaces or under unstable physical conditions. Containers for rearing the larvae must be of non-toxic material. The largest containers possible, over which control can be maintained should be used. For gas exchange, the containers must provide adequate surface in relation to volume. The shape of the container should be such that it presents a minimal solid surface area and freely permits water movement parallel to all surfaces. Cylinders appear to be the best available; hemispherical tanks would seem to be optimal. A constant current should be maintained in the rearing containers. Rheotaxis of the larvae causes them to orient against this current, and their encounters with interfaces are minimized.

Using the methods described in this paper, five species of marine fishes have been reared from egg stages to metamorphosis. Some other species were maintained for considerable periods of time after the yolk was exhausted but not to metamorphosis. Several species collected as larvae were reared to metamorphosis.

Physical factors which have been found influential upon rates and modes of development of fishes include temperature, aeration, light, and salinity. Of these factors, temperature has been shown to be generally the most influential and it is also the most difficult to control within narrow limits if one is to provide for the other environmental requirements.

Yolk-rich eggs and larvae of invertebrate species that can be kept in sustained supply for protracted periods appear to be the best source of food for larval fishes in the laboratory.

Symptoms of mortality observed during the course of this investigation were failure of the gas bladder to become functional, and renal disturbances. By inference, unstable temperatures are considered responsible for much of the inexplicable mortality and perhaps some of the mortality associated with well defined symptoms (e.g. renal disturbances) as well. Use of the term "critical period" is continued in its traditional sense (i.e. the period during which the yolk is exhausted and the larvae must begin active feeding). However, in the culture of marine fishes we can expect the larvae to be unusually sensitive to deviations from conditions of their native habitat until organogenesis is completed. (From auth. summ.)

1005. Wikgren, Bo-J. 1956. A COUNTER FOR REGISTRATION OF IMPULSES IN ACTIVITY PATTERN EXPERIMENTS. Memo. Soc. pro Fauna et Flora Fennica, Vol. 31, 1954-1955, pp. 97-98.

This apparatus consists chiefly of two parts (1) a frame with crossed nylon line suspended in the middle of an aquarium which, when jerked by a fish's movement through this obstacle, operates an electrical switch, and (2) an electrical counter of the impulses generated by the closing and opening switch. The counter consists mainly of 12 telephone impulse counters, a rotary selector switch, and a clock to group counts on an hourly basis.

1006. Wikgren, Bo-J. 1956. DAILY ACTIVITY PATTERN OF THE BURBOT. Memo. Soc. pro Fauna et Flora Fennica, Vol. 31, 1954-1955, pp. 91-97.

The daily activity pattern of the burbot (Lota vulgaris) was studied in aquaria with the aid of an electrical registration counter (see abstract #1005). The burbot was found to be chiefly active at night, though three peaks — 1-2 hours before sunrise, 1-2 hours after sunrise, and a peak between midnight and 3:00 a.m. — were evident. The activity pattern and the mechanisms affecting it are discussed.

1007. Schoffman, Robert J. 1957. AGE AND RATE OF GROWTH OF THE CARP IN REELFOOT LAKE, TENNESSEE, FOR 1941 AND 1956. Reprint from the J. of the Tenn. Acad. of Sci., Vol. 32, No. 1, Jan., pp. 3-8.

Age groups IV through XII were represented in both the 1941 and 1956 samples. In both years the weight and length increment was greatest for age group VIII. No specimens longer than 29 inches nor heavier than 200 ounces were taken, and in both years the oldest fish were in age-group XII. The average weight in each age-group in 1956 was greater than in 1941. In the 1956 sample, age-group VII were the most numerous at which time they averaged 19.3 inches and 60.7 ounces, followed by age-group VI, then age-groups V, IV, and VIII.

1008. Hasler, Arthur D. 1956. PERCEPTION OF PATHWAYS BY FISHES IN MIGRATION. Reprint. from The Quart. Rev. of Biology, Vol. 31, No. 3, Sept., pp. 200-209.

An appraisal of the various senses and their role in orientation during migration is made, treating each sensory system separately. Pertinent literature is reviewed, and the lines of research considered to be the most productive is pointed up.

1009. Milne, D. J. and E. A. R. Ball. 1956. THE MORTALITY OF SMALL SALMON WHEN CAUGHT BY TROLLING AND TAGGED OR RELEASED UNTAGGED. Prog. Reps. of the Pacific Coast Stations, No. 106, Sept., pp. 10-13.

The mortality involved in catching and releasing small spring and coho salmon from commercial trolling gear is suggested to be about one-third, initially, with a final total loss of about one-half of the fish. In releasing either small coho salmon prior to an opening date or small spring salmon below a minimum size limit, a mortality of one-half would appear to be offset only if the survivors double their weight; but even then no gain in net production could result since only a portion of the fish could be recaptured. Because of this high

mortality, any regulation requiring the release of small troll-caught salmon does not appear to be a promising conservation measure.

Even when only the fish that are landed in good condition are released, as was done in the tagging experiments from trollers, the mortality is probably about one-third. The high tagging mortality, together with the natural mortality and spawning escapement, accounts for the low tag return of about 10 percent from the intensive fisheries. By using barbless hooks both the tagging and releasing mortalities would probably be substantially reduced. (Auth. summ.)

1010. Brett, J. R. and D. F. Alderdice. 1956. LAKELSE RIVER EXPERIMENTS ON GUIDING SOCKEYE AND COHO SALMON FINGERLINGS. Prog. Reps. of the Pacific Coast Stations, No. 106, Sept., pp. 14-20.

Tests were made of a deflector consisting of a row of galvanized sash chains suspended at 4-inch intervals from an aluminum pipe and vibrated at rates up to 160 o.p.m. with 2-, 4-, or 6-inch strokes. Deflection of 79 percent of sockeye yearlings was obtained when this device was vibrated at an average of 153 o.p.m. with 4-inch strokes; slower rates and shorter strokes decreased the efficiency of deflection. No success with coho yearlings was obtained, apparently due to the loose, dispersed grouping of coho compared to the strong schooling behaviour of sockeye. As water velocities approached 1.0 ft./sec. effectiveness decreased; sockeye passed through the deflector even though struck by moving chain links. In addition, repeated experience with the deflector reduced its effectiveness.

The other deflector tested consisted of a curtain of 1/4-inch cables hanging vertically and moving horizontally on an endless belt, the up-stream row moving toward the by-pass and reversing direction at the by-pass. Rates of travel could be varied to 4, 8, and 12 inches per second and cable intervals altered to 4, 6, 8, and 10 inches.

The critical rate of travel occurred at about 8 to 12 in./sec.; higher rates improved deflection. The critical cable interval was 4 to 6 inches; deflection diminished at greater intervals. At critical levels, an average deflection of 89 percent of the sockeye (range 86 to 94 percent) and 58 percent of the coho (36 to 81 percent) was obtained. Bright artificial lighting at night did not improve efficiency. The rheotropic response and the reticence of grouped fish to pass through verticle "slits" provide the basis for this simple mechanical deflector which has little effect on free passage of water. Main reasons why efficiency was not greater was the poor angle of deflection (90°), presence of large predators and coarse fish which occasionally scared young salmon through the deflector, and some unattractive features of the by-pass. Approximately 144 c.f.s. flowed through the deflector and by-pass, only 24 c.f.s. entering the by-pass.

1011. Manzer, J. I. 1956. DISTRIBUTION AND MOVEMENT OF YOUNG PACIFIC SALMON DURING EARLY OCEAN RESIDENCE. Prog. Reps. of the Pacific Coast Stations, No. 106, Sept., pp. 24-28.

In 1955, as part of Canada's share of the research program adopted by the International North Pacific Fisheries Commission, the Fisheries Research Board's Biological Station at Nanaimo undertook studies of young salmon in the sea. The primary objective of these studies was to discover the distribution and movements of young salmon after they have left fresh water.

The results, sketchy though they are, do indicate the spread of young pink and chum salmon seaward, the presence of concentrations close to shore until late July or early August and movement away from shore at about that time. By early September, pink salmon were found at least 12 miles from land; chum salmon at least 1 mile. Young sockeye, in the northern area at least, were not caught as successfully, perhaps because they did not concentrate on the beaches in the same manner. Such catches as were made in both areas suggest a similar movement and disappearance from inshore areas late in the summer. (Auth. summ.)

1012. Tully, John P. and A. J. Dodimead. 1956. PACIFIC SALMON WATER? Prog. Rep. of the Pacific Coast Stations, No. 107, Nov., pp. 28-32.

On Project Norpac, 12 oceanographic agencies around the Pacific made a synoptic survey of the ocean north of the Tropic of Cancer during the period mid-July to mid-September 1955. Each agency surveyed a part of the area and exchanged data with each other. This provided the first overall picture of the northern ocean and has made it possible to discuss some of the principal oceanographic features which distinguish the parts of the ocean where salmon occur from those where they do not.

There are two distinct regions. The mid-ocean region south of latitude 38° N. is in the sub-Tropics. Here the surface waters are warm, generally above 24° C., and saline, greater than 35 parts per thousand, in all seasons. Both the temperature and salinity decrease with depth. Sub-Arctic water occurs along the Aleutian Islands and in the Gulf of Alaska, north of latitude 48° N. Here the surface waters are warmed in summer, maximum of 10-12° C., and cooled in winter, and have a low salinity of less than 32.8 parts per thousand, in all seasons. Temperatures during the summer decrease with depth and during the winter assume those of the deeper water; salinity increases with depth.

Fishing experience around the north Pacific shows that salmon occur in all the coastal waters which have the same temperature and salinity characteristics as the sub-Arctic waters in the Gulf of Alaska. Data from exploratory fishing during the summer of 1955 indicates that salmon occur in the waters having these properties, but do not occur outside of them. The temperatures of these waters vary greatly through the year. In the coastal region the salmon tolerate surface temperatures from less than 5° up to 20° C. (41° to 68° F.). Salmon have not been sought on the

high seas in winter, but in view of the coastal experience it is reasonable to assume that they would not desert the northern seas because of the low winter temperatures. Further, it appears probable that salmon are associated with the northern salinity structure, that is, an upper zone of low salinity.

1013. Ranade, M. R. and H. G. Kevalramani. 1956. EXPERIMENTAL AIR-SHIPMENT OF CARP FRY IN PLASTIC BAGS. Indian J. of Fish., Vol. 3, No. 2, Oct., pp. 290-293.

Carp fry, 0.75 to 1.00 inches in size, were conditioned and then placed in plastic bags. Each bag measuring 33 inches in length by 24 inches in width was placed in an empty 4-gallon kerosene tin, air was expelled by compressing the bag to water level, oxygen was pumped in, the top of the bag was tied, and the container was then placed in a cardboard carton. Water temperature was 30° C. and oxygen content was 7.72 ppm. One bag had 1200 fry, the other 2,300.

Upon arrival at Bombay, 12 hours after departure by plane from Calcutta, mortality was approximately the same for both groups, 2.25 percent for the 1200 and 3.5 percent for the 2300, and water temperatures were nearly identical, 27.2° C. and 27.3° C. Dissolved oxygen content was 8.6 ppm. for the water containing 1200 fish and was 3.6 ppm. for the other bag. Fry were active and appeared normal in both bags. Comparing air and rail transportation, it is concluded that the former is not only a simpler operation, but less costly.

1014. Brook, A. J. and W. B. Woodward. 1956. SOME OBSERVATIONS ON THE EFFECTS OF WATER INFLOW AND OUTFLOW ON THE PLANKTON OF SMALL LAKES. The J. of Anim. Ecol., Vol. 25, No. 1, May, pp. 22-35.

Four years' observations on the plankton populations of four Scottish hill lochs have shown that their density tends to be highest and that they are most stable in lochs with a low rate of water replacement. Detailed studies were made during the spring and summer of 1954 on the plankton and replacement of water in one of these lochs having a low rate of replacement and in another with a high rate in order to determine more precisely the influence of this factor. These studies indicated that at times the rate of replacement may be a factor of over-riding importance and may produce not only quantitative but also qualitative differences in the plankton. Some observations were made on the effectiveness with which different species and age-groups of individual species of zooplankton can avoid being carried down the outflows of lochs.

The results of this investigation indicate that the standing crop of plankton cannot be used as a measure of the productivity of small lakes, particularly where the replacement of water may be considerable. (Auth. abst.)

1015. Slastenenko, E. P. 1956. THE GROWTH OF YELLOW PIKEPERCH, STIZOSTEDION VITREUM (MITCHILL) IN THREE MILE LAKE, ONTARIO. The Canad. Fish Cult., Issue 19, Nov., pp. 17-24.

This study is based on 476 specimens, with frequencies in age-groups I through IX of 12, 34, 35, 158, 190, 32, 7, 7, 1, taken from Three Mile Lake during the years 1952 through 1954. Average total length in inches and weight in ounces calculated to end of year for age-group I are 4.8 and 0.9; for age-group II, 7.2 and 2.4; III, 9.3 and 4.6; IV, 11.5 and 7.9; V, 12.4 and 10.2; VI, 14.4 and 19.9; VII, 15.0 and 54.0; VIII, 19.7 and 54.2; IX, 24.5 and unknown weight.

This shows a fairly uniform and relatively slow growth pattern. In the older age-groups the rate of weight increase is faster than the rate of length increase. Their average total length of 4.8 inches in the first year is about average when compared with growth rates reported for other waters, but growth thereafter is relatively poor. There is a small difference in the rates of growth of the sexes after the third year, when the females grow faster. The coefficient of condition averaged 1.38 and tended to vary with the age of the fish. This is somewhat lower than that reported from most other waters and may reflect poorer growing conditions.

1016. Smith M. W. 1956. FURTHER IMPROVEMENT IN TROUT ANGLING AT CRECY LAKE, NEW BRUNSWICK, WITH PREDATOR CONTROL EXTENDED TO LARGE TROUT. The Canad, Fish Cult., Issue 19, Nov., pp. 13-16.

At 50-acre Crecy Lake, Charlotte County, hatchery-reared brook trout have been planted, the waters of the lake enriched with commercial fertilizers, and the control of trout enemies undertaken in attempts to improve angling. Published results show that the combination of stocking, fertilization, and predator control of fish-eating birds and mammals and the eel, resulted in much improved fishing for brook trout during the period 1943-1953. Results presented in this paper for 1954 and 1955, during which predator control was continued, show that of the fingerlings and yearlings planted in 1953 anglers captured 22 and 68 percent, respectively. In 1954, predator control was extended to a reduction of older trout in the lake and only fingerlings were planted. In 1955, the high survival of 41 percent of these fingerlings to the anglers' catches was realized, well illustrating the value of predator control.

1017. Godfrey, H. 1956. CATCHES OF FISH IN NEW BRUNSWICK STREAMS BY DIRECT CURRENT ELECTRO-FISHING. The Canad. Fish Cult., Issue 19, Nov., pp. 1-8.

The electrical equipment consisted of a 1,000-watt D.C. generator, a positive electrode carried by the operator, and a negative electrode consisting of a small square of copper screening grounded to the river bed. While fishing, the potential supplied and the current drawn varied from 600 to 700 volts and from 1.0 to 1.7 amperes. The combined area of the 12 screened-off sections of four salmon streams fished with this equipment was 3,003 square yards from which 2,958 fish belonging to 14 different species were taken. The total captures were considered to be close estimates of the total numbers

of each species present. Species taken included black-nosed dace, salmon fry and parr, eels, sculpin, brook trout adults and fry, burbot, and "other minnows". Black-nosed dace, salmon fry and parr, and eels were the most numerous, composing over 2,200 of the 2,958 fish taken. The success of the electro-fishing depended greatly upon the facts that all the experimental sections were between 1 and 3 feet in depth and that the electrical conductivity of the water was suitable for the apparatus in use, providing a fairly wide electrical field.

1018. Loftus, K. H. 1956. EXPERIMENTAL STORAGE OF LAKE TROUT EGGS. The Canad. Fish Cult., Issue 19, Nov., pp. 9-11.

Occasional high losses of eggs and fry of lake trout appeared to be caused by rapid rate of development associated with high water temperatures. In an attempt to avoid these apparent effects of high temperature, an experiment was undertaken to determine if lake trout eggs could be stored after fertilization until water temperatures at the hatchery became suitably low. Unfortunately this test was made in a year of favorable water temperatures and thus failed to demonstrate any substantial reduction of losses through storage. It did demonstrate, however, that losses were not increased by storage, thereby permitting a reasonable inference that losses due to unfavorable water temperatures could be reduced by storage until favorable temperatures prevailed. It was further demonstrated that embryo development can be retarded by storage for up to 28 days at 40° F. without increasing total mortality above that which would be expected under normal temperatures.

1019. Rigler, F. H. 1956. A TRACER STUDY OF THE PHOSPHORUS CYCLE IN LAKE WATER. Ecology, Vol. 37, No. 3, July, pp. 550-562.

The phosphorus cycle in small, acid-bog Toussaint Lake was studied by the use of radioactive phosphorus. Of the total P^{32} added to the surface, 77 percent was lost from the water and plankton in 4 weeks but only 2 percent was lost through the outlet and 3 percent to the mud. It was concluded that there was a turnover of "mobile" phosphorus of the epilimnion with phosphorus of the littoral organisms. The turnover time of phosphorus of the epilimnion with respect to this exchange was found to be 3.5 days. The similarity between this value and the turnover times of inorganic phosphate calculated by Hayes et al. (1952) is considered to be fortuitous.

Several days after the addition of P^{32} to the lake, 50 percent had passed into the fraction of plankton removed by a Foerst centrifuge. Laboratory experiments showed that neither a Foerst centrifuge nor filter paper removed the organisms which took up P^{32} most rapidly. When complete removal of plankton was achieved by filtering water through a Millipore bacterial filter it was shown that over 95 percent of the added P^{32} was taken up by plankton within 20 minutes. The turnover time of inorganic phosphate in the surface water of Toussaint Lake was approximately five minutes. Measurements of turnover made in two other small lakes suggested that a rapid turnover of inorganic phosphate is not peculiar to Toussaint Lake.

In laboratory experiments with mixed and pure cultures of aquatic bacteria, loss of P^{32} from solution and loss from suspension were used to measure uptake of phosphate by bacteria and extent of attachment of bacteria to the walls of glass containers respectively. Growing bacteria rapidly utilized inorganic phosphate from lake water but when sterile water was stored there was no loss of phosphate from solution. Attachment to the walls was not essential for the growth of most species of bacteria which multiplied and utilized phosphate during the first days of storage.

The turnover of phosphate under natural conditions appeared to be caused primarily by bacteria. It was concluded that aquatic bacteria might compete with algae for inorganic phosphate. (Auth. summ.)

1020. Brown, Seward R. 1956. A PISTON SAMPLER FOR SURFACE SEDIMENTS OF LAKE DEPOSITS. Ecology, Vol. 37, No. 3, July, pp. 611-613.

A simple, inexpensive surface sediment sampler of the piston type is described and its operation outlined. Its primary advantages are that (1) undisturbed cores of lake sediments can be taken through the mud-water interface to depths of 75 cm., and (2) by employing a clear plastic tube, it permits visual inspection of the intact core. (Auth. summ.)

1021. Bovbjerg, Richard V. 1956. A LABORATORY CULTURE METHOD FOR CRAYFISH. Ecology, Vol. 37, No. 3, July, pp. 613-614.

Washington University in St. Louis has maintained a breeding population of a pond species, Procambarus allenti, for 6 years in a 4-foot by 6-foot concrete tank. Three provisions seem to have been of most importance to the success of this venture. The species cultured was tolerant of environmental extremes; the substratum of crushed limestone, hollow tiles, bricks, and rocks furnished refuge for molting individuals; and continuous illumination maintained a rich green flora. Supplemental feeding was done on a very casual basis. Artificial aeration was continuous. To obtain large numbers of young, a female bearing hatching eggs was placed in a finger bowl with coarse rock bottom. With removal of the female and addition of green algae, young were reared through two or three molts.

1022. Cope, Oliver B. 1956. SOME MIGRATION PATTERNS IN CUTTHROAT TROUT. Proc. Utah Acad. of Sci., Arts, and Letters, Vol. 33, pp. 113-118.

Migrating cutthroat trout spawners in Arnica Creek, Yellowstone National Park, were counted day and night, in 1951. Five-sixths of the total count for the season entered the stream between 6 p.m. and 7-8 a.m. This nocturnal migration is unusual for salmonid spawners, and is explained

by the response of spawners to evening freshets that occur during the season of melting snows.

Lakeward-migrating cutthroat fry in the same stream were counted, and it was found that 88 percent of the total count from August 1 to 15 moved downstream at night. Nocturnal movements of fry have been observed in other trouts and in salmon, and have been attributed to a negative phototropism. (Auth. summ.)

1023. Clarke, George L. and Gunther K. Wertheim. 1956. MEASUREMENTS OF ILLUMINATION AT GREAT DEPTHS AND AT NIGHT IN THE ATLANTIC OCEAN BY MEANS OF A NEW BATHYPHOTOMETER. Deep-Sea Res., Vol. 3, No. 3, April, pp. 189-205.

The bathyphotometer described is a combination of a light-meter employing a photomultiplier tube and a depthmeter employing a bourdon tube. The spectral sensitivity of the instrument extends approximately from 320 mu to 650 mu with a maximum at 480 mu. Illumination as low as 10^{-7} uw/cm^2 (about 10^{-12} of full sunlight) and depths as great as 610 m can be read directly on deck. The instrument thus permits the direct investigation of the light factor in the sea at depths and intensities far below those measurable by photovoltaic photometers.

Measurements of transparency made in the Florida Current off Miami gave extinction coefficients ranging from .031 to .056 for various strata between depths of 20 and 580 m. In the slope water about 200 miles SE of New York extinction coefficients of .062 to .072 were obtained for the upper 90 m and of .032 to .041 for layers extending to 596 m. These results, together with previous meager information, indicate a uniform and high transparency for the water between 100 m and 600 m.

Measurements made at night in both localities showed that the illumination decreased with depth in the upper layers at about the same rate as during the day. Flashes of light, presumably from luminescent animals, were observed, particularly in the lower strata. At depths greater than 300 m the background light remained about constant or tended to increase. In one instance the general illumination at night at 600 m was about as great as during the day with individual flashes almost on thousand times greater. (Auth. abst.)

1024. Mraz, Donald and Edwin L. Cooper. 1957. REPRODUCTION OF CARP, LARGEMOUTH BASS, BLUEGILLS, AND BLACK CRAPPIES IN SMALL REARING PONDS. J. Wildl. Mgt., Vol. 21, No. 2, April, pp. 127-133.

The present study was designed to determine the success of natural reproduction and early survival of carp, largemouth bass, bluegills, and black crappies in small ponds with mixed populations of mature fish at known densities in southern Wisconsin. Adult fishes were stocked in ponds in April or May, and the ponds were drained in September or October. During this period, the percentage survival of adult carp far exceeded that of the other species, as follows: carp, 95.9; largemouth bass, 49.5; bluegills, 35.8; and black crappies, 44.0. There was little apparent correlation between the number of brood fish stocked in the ponds and the strength of the resulting year class. There was also little consistency in the success of natural reproduction of a particular species from one year to the next when the same combination of species was used to stock the ponds. The range in standing crop of the young of each species during the 3-year period, expressed as the number of fish per acre, was very great; carp, 7 to 6,340; largemouth bass, 0 to 12,305; bluegills, 494 to 13,560; and black crappies, 0 to 503. (Auth. abst.)

1025. Churchill, Warren. 1957. CONCLUSION FROM A TEN-YEAR CREEL CENSUS ON A LAKE WITH NO ANGLING RESTRICTIONS. J. Wildl. Mgt., Vol. 21, No. 2, April, pp. 182-188.

Escanaba Lake in northeastern Wisconsin has been open to unrestricted hook and line fishing since 1946. A complete record of the harvest and other information are collected by a compulsory permit system. In 10 years, 97,387 fish weighing 49,414 pounds were taken. The average annual harvest was 16.9 pounds per acre. Average fishing success was 0.24 fish per hour. Walleye (Stizostedion vitreum) and perch (Perca flavescens) made up 80 percent of the harvest but the proportions of the 2 species varied greatly. Fishing restrictions in effect elsewhere in Wisconsin would have reduced the catch of game fish by more than 50 percent. Minimum size limits would have had more effect than bag or season limits. There is no evidence of depletion after 10 years of unrestricted fishing. (Auth. abst.)

1026. Taylor, Glenn N., Larry S. Cole, and William F. Sigler. 1957. GALVANOTAXIC RESPONSE OF FISH TO PULSATING DIRECT CURRENT. J. Wildl. Mgt., Vol. 21, No. 2, April, pp. 201-213.

The galvanotaxic response of fish to continuous direct current and pulsating direct current, using 0.33, 0.47, and 0.88 duty cycles with a triangular voltage wave shape was investigated. The reaction to alternating current was also studied.

Employing pulsed direct current, the most efficient leading response occurred when using a 0.33 duty cycle, pulsed at 96 times per second. This pulsed direct current technique produced good galvanotaxic response using 45 percent of the voltage and 20 percent of the power which would be required when using continuous direct current. Tests using 0.47 and 0.88 duty cycles indicated that these tended to be less efficient than the 0.33 duty cycle.

Observations concerning the harmful effects to the fish resulting from the electrical shocks indicated that losses when using steady direct current or pulsed direct current are insignificant. No losses occurred in 91 fish shocked with continuous direct current, 0.3 percent mortality occurred in shocking 1,641 fish with pulsed direct current, and

4.2 percent mortality occurred in shocking 46 fish with alternating current. The cause of death in most instances appeared to be factors that could not be observed either grossly or microscopically.

This study indicates that the efficiency of a direct-current machine can be increased through the use of triangular-shaped voltage pulses, 0.33 duty cycle, and a relatively fast pulse rate. (Auth. abst.)

1027. Marzolf, Richard C. 1957. THE REPRODUCTION OF CHANNEL CATFISH IN MISSOURI PONDS. J. Wild. Mgt., Vol. 21, No. 1, Jan., pp. 21-28.

Channel catfish can be induced to spawn in ponds by the provision of suitable nests. Wooden nail kegs proved to be satisfactory as nesting sites. Nests made by partially telescoping two kegs of different sizes proved superior to single keg nests. Nests should be scattered about the pond in a variety of situations since some nests were used repeatedly while others, in situations equally suitable (to the human eye), were ignored. Brood fish newly introduced into a pond require a period of acclimatization before reproduction will proceed at a normal rate. The acclimatization period seems to be more than 1 year for pond-reared fish and at least 2 years for river fish. The cessation of spawning during the acclimatization period apparently is caused by failure of the females to develop sexually. Males appeared to be normally developed. In central Missouri the spawning season for channel catfish in ponds extends from late May to mid-July, with two peaks occurring in early June and late June. Hatching success ranged from 70 to 88 percent during the 3 years of study. There was evidence that multiple use of nests reduced hatching success and that the first spawn was somewhat less likely to hatch than the second when a nest was used twice. Survival of young through the first year appears to be the chief problem in establishing self-perpetuating populations of channel catfish in ponds. There seems to be a direct correlation between survival and the turbidity of the water. Survival was satisfactory in ponds stocked with catfish alone but was variable in ponds containing established populations of other species. (J. L. F.)

1028. Blaxter, J. H. S. 1957. HERRING REARING—III. THE EFFECT OF TEMPERATURE AND OTHER FACTORS ON MYOTOME COUNTS. Scot. Home Dept., Mar. Res., No. 1, 16 pp.

Counts of myotomes have been made on herring larvae of different parentage and 'race', hatched in the laboratory at different incubation temperatures ranging from 5.1° C. to 14.68° C. Counts were made to the anus and to the end of the body.

The apparent total number of myotomes was found to increase between hatching and absorption of the yolk sac; the anal number does not increase between these stages. A higher number of myotomes (both anal and total) was found at the lower incubation temperatures than at the higher temperatures. A change in mean by as much as two myotomes for 9 deg. C. was recorded. There was no obvious influence of parental vertebral count on the myotome count of the offspring. There was no obvious influence of race on myotome count except that the range of counts of spring-spawned larvae was wider than that of autumn spawned at the extremes of temperature used. Between 8.5° C. and 11.5° C. the counts of spring and autumn spawned larvae were very similar.

There was no significant difference in myotome counts of the progeny of an autumn-spawning female crossed with a spring-spawning male and the progeny of the same autumn-spawning female crossed with an autumn-spawning male. A correlation between myotome and vertebral count was found, indicating that results for myotome counts were applicable to vertebral counts as well. (Auth. summ.)

1029. Aron, William I. 1956. FOOD OF SALMONID FISHES OF THE NORTH PACIFIC OCEAN. Univ. of Wash., Dept. of Oceanography, Fish. Rep. No. 4, Nov., 10 pp.

This report presents data on the analysis of volume and content of stomachs of pink salmon (Oncorhynchus gorbuscha). The salmon were collected by the Japanese oceanic gill-net fishery from three geographic regions in the northwest Pacific Ocean. A comparison is made between feeding behavior of pink, sockeye, and chum salmons. The abundance of juvenile rockfish found in the stomachs of pink salmon indicates a possibly commercially fishable population of adult rockfish. (Auth. abst.)

1030. Tait, J. S. 1956. NITROGEN AND ARGON IN SALMONOID SWIMBLADDERS. Canad. J. of Zool., Vol. 34, No. 1, Feb., pp. 58-62.

Analyses of 44 swimbladder gas samples from lake trout, lake whitefish, shallow-water cisco, deepwater cisco, and bloater caught at 60 - 300 feet in Lake Huron showed no measurable quantities of combustible gas. Noncombustible gas ranged from 90 to 98 percent. The argon X 100/ nitrogen in a gas sample from a whitefish was 1.02, virtually the same as in air. The noncombustible gas is composed apparently of the inert gases of the atmosphere. (Auth. abst.)

1031. Applegate, Vernon C., John H. Howel, A. E. Hall, Jr., and Manning A. Smith. 1957. TOXICITY OF 4,346 CHEMICALS TO LARVAL LAMPREYS AND FISHES. Spec. Sci. Rep.—Fish. No. 207, U. S. Fish and Wildlife Service, March, 157 pp.

Information obtained in screening tests on the apparent toxic effects of 4,346 compounds on larvae of sea lamprey, rainbow trout, and bluegill sunfish is presented in tabular form. Methods of preliminary screening and reporting data are covered. Among those tests where all three test animals were exposed, 264 substances were toxic to only one species at the levels of concentration and temperature employed, and 333 additional compounds were toxic to only two species.

1032. Sand, R. F. and R. L. McNeely. 1956. UNDERWATER TELEVISION VEHICLE FOR USE

IN FISHERIES RESEARCH. Spec. Sci. Rep. - Fish. No. 193, U. S. Fish and Wildlife Service, Dec., 15 pp.

This report describes the design and construction of an underwater television vehicle having a useful working range down to 50 fathoms; the ability to hover, be placed on the bottom, or be towed at speeds up to 3 knots; and the capability of being scanned 360° in azimuth and 90° in elevation. All control functions can be manipulated from a single position and observations can be recorded by camera.

1033. Bailey, Reeve M. and Frank B. Cross. 1954. RIVER STURGEONS OF THE AMERICAN GENUS SCAPHIRHYNCHUS: CHARACTERS, DISTRIBUTION, AND SYNONYMY. Papers of the Mich. Acad. of Sci., Arts, and Letters, Vol. 39, pp. 169-208.

This paper verifies the specific, though not generic, distinctness of S. platorynchus and S. album, presents descriptive measurements and meristic counts, contrasts the species in certain differential characters, lists new records of specimens, and includes a map of the known geographic ranges.

1034. Jensen, Hans M. 1956. MIGRATORY HABITS OF PINK SALMON FOUND IN THE TACOMA NARROWS AREA OF PUGET SOUND. Fish. Res. Papers, Vol. 1, No. 4, March, pp. 21-24.

In 1955, 873 pink salmon averaging 2-3 pounds were tagged in the Tacoma Narrows area to determine their area of origin and comparative contribution to the sport and commercial fisheries of Puget Sound. Both conventional Peterson disc tags and plastic spaghetti tags were used. Tag returns indicated that these resident pink salmon remained around Point Defiance and the Narrows until mid-July, and then moved northward so that by September 15, they were centered in the southern Whidbey Island—Port Susan area. Three recoveries from the Stillaguamish River suggest that an important segment enters that river. Some straying from this pattern was noted.

Commercial gill net gear designed to catch 5-7 pound ocean-reared pink salmon most likely does not catch many of the 3-4 pound resident stock. This presented an opportunity to test the selective action of a Peterson tag, as fish with spaghetti tags would pass through the gill nets while those with Peterson tags would ordinarily be retained, and also to determine whether the resident stock was unfishable by this gear. Recoveries by sport gear, drag seines, and gill nets totaled 421 tagged fish. Sport gear showed no selectivity, in direct contrast to high selectivity of gill nets for Peterson tags. Eight Peterson tag recoveries compared to one spaghetti tag recovery indicates, in addition to selectivity for Peterson tags, that gill nets would not retain untagged resident salmon to any great extent.

1035. McKinley, W. R. and R. D. Webb. 1956. A PROPOSED CORRECTION OF MIGRATORY FISH PROBLEMS AT BOX CULVERTS. Fish. Res. Papers, Vol. 1, No. 4, March, pp. 33-45.

This study was initiated to provide a low cost, simple, and effective means of passing upstream migrant salmon through culverts. Rectangular culverts to a maximum grade were studied. A model was built which conformed as nearly as possible to prototype conditions, and paired, alternate, and offset baffle arrangements were tested for usefulness. A grading procedure was initiated to evaluate the various arrangements, the most successful of which was the offset baffle fishway consisting of 30° angle baffles on one side and 90° angle baffles on the opposing side in a slightly staggered array. This arrangement produced a good flow pattern at all slopes and discharges tested.

Special emphasis was placed on ease of installation. The final design is simple and the baffles lend themselves to construction from wood or precast concrete. The baffles may be easily installed in older culverts by drilling and grouting. At high flows the self-cleaning qualities of the offset baffle fishway are positive and complete.

The approach in this study was entirely empirical as no mathematical formulae were available to predict flow pattern, energy dissipation, and other hydraulic peculiarities. No attempt was made to investigate other than rectangular culverts as these have presented the greatest problems in the field. These studies also form a basis for computing the effects of the use of baffles when under unusual conditions the present culvert placement standards of the department cannot be met. (Auth. summ.)

1036. Ellis, C. H. 1956. TESTS ON HAULING AS A MEANS OF REDUCING DOWNSTREAM MIGRANT SALMON MORTALITIES ON THE COLUMBIA RIVER. Fish. Res. Papers, Vol. 1, No. 4, March, pp. 46-48.

In 1955, five lots of 200,000 90-day-old chinook salmon each were fin-clipped and released at points providing as great a geographical spread as possible between the Klickitat River salmon hatchery and salt water. One group was released at the hatchery, approximately 205 miles from the sea; another was hauled by truck to the confluence of the Klickitat and Columbia Rivers, then barged downstream 165 miles past Bonneville Dam and released at a point off Skamokowa; another group was released at the confluence of the Klickitat and Columbia Rivers; another group was hauled by truck to the barge release point off Skamokawa, and the last group was trucked to and released at the Elokomin Hatchery on the Elokomin River which joins the Columbia River a short distance above Skamokawa. At least 200 miles of predator-infested water and Bonneville Dam had been bypassed by three groups in trucks and a barge while two groups had to traverse at least 165 miles of the Columbia River and Bonneville Dam. Recovery of marked fish below Bonneville Dam within 10 days of their release upstream gave some indication of migration speed and population losses. Of those released at the Klickitat Hatchery, 254 were recovered

while 362 were recovered from the group released at the mouth of the Klickitat River. This would indicate that 40 percent larger liberations would have to be released at the former to match survival of the latter group. Final conclusions will depend upon return of these fish in 1958.

Recoveries of marked fish at Bonneville also indicated that fish did not follow the shore from which they were liberated, but tended to follow the pattern of heaviest water flows.

1037. Dunstan, William A. and Wallace E. Bostick. 1956. NEW TATTOOING DEVICES FOR MARKING JUVENILE SALMON. Fish. Res. Papers, Vol. 1, No. 4, March, pp. 70-79.

This article describes a portable tattooing device, suitable for use in the field, and a stationary tattooing device for marking large numbers of fish. Field crews using the portable device marked 300 to 400 chinook salmon 1.25 to 1.75 inches long per hour while operators of the stationary device averaged 3,218 chinook fingerlings per day. Of 1,231,000 fingerlings marked by the latter device at McNary Dam, only 0.49 percent died during the 2- to 5-day holding period. Analine dyes proved to be unsatisfactory due to a short retention period or difficulty in use. Inert pigments, aluminum oxide, ferric oxide, and chrome green, however, had good retention qualities and were much more suitable for the equipment described.

1038. Schäperclaus, W. 1956. BEKÄMPFUNG DER INFEKTIÖSEN BAUCHWASSERSUCHT DES KARPFENS DURCH ANTIBIOTIKA (Control of Infectious Dropsy of Carp With Antibiotics). Zeitschr. f. Fischerei, Vol. 5, No. 1-2, pp. 3-59. (Most of the information on the treatment of the infectious dropsy in carp by antibiotics was published before in two preliminary papers which were abstracted in the Sport Fishery Abstracts, Nos. 607 and 608. Abstractor's note).

Measures for the control of the infectious dropsy caused by Aeromonas liquefaciens (Pseudomonas punctata) are maintenance of balance between the host and the pathogen, selection and breeding of disease resistant fish, use of specific bacteriophage (expensive and complicated), use of polyvalent vaccines (induced immunity too low to be of significance), and chemotherapy with antibiotics.

Aeromonas liquefaciens can be found in the intestinal tract of about 50 percent of apparently healthy carp. This bacterium apparently becomes a pathogen when the resistance of fish is lowered. The period of lowest resistance is in the spring when the protein of carp blood is low and fish are debilitated due to winter dormancy. Cross infections with different strains of the organism are possible when fish are transferred between fish farms. The best prophylaxis of infectious dropsy was obtained when chloramphenicol was injected intraperitoneally to carp at the time of spring stocking of ponds. The dosage was 2 milligrams per 100 grams of fish. The protective value of the antibiotic was the same if given orally; this, however, is usually impossible in practice because warm-water fish usually do not take food readily at this time of the year. The levo-rotatory isomer of chloramphenicol is the most effective, therefore the racemic and d-isomers should not be used.

Anticipated undesirable results of prophylaxis with chloramphenicol are the appearance of drug-resistant strains of the pathogen and survival of fish which genetically are susceptible to this disease. (S. F. S.)

1039. Menzel, H. M. 1957. ZU DEN GESUNDHEITSKONTROLLEN AN SATZFISCHEN (Sanitary Controls of Brood Fishes). Deutsche Fischerei Zeitung, No. 2, pp. 43-44.

In 1956, a central station for the maintenance of high production standards in pond fish culture was established in Soviet Occupied Eastern Germany. One of the important purposes of this station is the health control of the brood fish which may be transported between different fish farms. Personnel of the station examine fish before shipment. Fish condemned as having a communicable disease can be used for breeding purposes on the farm of origin only, but not transferred to other farms. The control examinations will be carried out in spring and fall. Fish species subject to examination are: carp, tench, pike perch, and trout (Bach-und Regenbogenforellen). All imported and exported fish must also be examined. A record of examination is kept in the control files and copies given to parties involved in the transaction. (S. F. S.)

1040. Pickford, Grace E. and James W. Atz. 1957. THE PHYSIOLOGY OF THE PITUITARY GLAND OF FISHES. Published by the N. Y. Zool. Soc., 637 pp., May 10. lithoprinted.

This publication is a review of the extensive and widely dispersed literature on the physiology of the pituitary gland of fishes. The nature of the fish pituitary gland hormones and their sites of origin are discussed. The regulation of the target organs and their functions is reviewed in relation to the biology of the organism as a whole, and a comparison is made with the knowledge of pituitary physiology in higher vertebrates.

Methods of treating fishes with gonadotropic hormones in order to induce reproduction in captivity are described in detail, including the extensive fish-cultural work that has been performed in Brazil, Japan, and the USSR. All known experiments, up to June 1956, concerning the pituitary gland and pituitary physiology of fishes are summarized in 54 tables. An addendum covers, insofar as possible, the literature for the last months of 1956. The technique of hypophysectomy is discussed in an Appendix.

There is a combined Bibliography and Author Index, consisting of 1,905 complete bibliographic references, accompanied by page references to citations in the text and tables. Cross references to co-authors are included. There is a detailed Subject Index. (From publication notice.)

1041. Carlander, Kenneth D. and Robert B. Moor-

man. 1956. STANDING CROPS OF FISH IN IOWA PONDS. Reprint from Proc. of the Iowa Acad. of Sci., Vol. 63, Dec. 6, pp. 659-668.

Standing crops of fish in 42 Iowa ponds, estimated by rotenoning or by marking and recapture techniques, ranged from 28 to 1,235 pounds per acre. Standing crops of over 300 pounds per acre were usually the result of an abundance of bullheads or buffalo, which have a short food chain. Bluegill populations were generally over 100 pounds per acre unless there was heavy competition from other species of fish or unless the pond had a high clay turbidity. Largemouth bass populations were difficult to estimate. The largest standing crop of bass, 80 pounds per acre, was in a pond with an abundance of yearling bass. (Auth. summ.)

1042. Collier, Albert. 1957. GULF-II SEMI-AUTOMATIC PLANKTON SAMPLER FOR INBOARD USE. Spec. Sci. Rep.-Fish. No. 199, U. S. Fish and Wildlife Service, Feb., 11 pp.

The Gulf-II semiautomatic plankton sampler was developed for studying heterogeneous plankton distribution in the Gulf of Mexico. By means of a circular rotating trough, eight consecutive hourly samples are collected on removable disks of bolting silk. The sampler collects continuously regardless of sea conditions, the intake being through the hull of the vessel at the lowest point possible. Water flow through the sampler is metered directly. Construction details and specifications are provided. (Auth. abst.)

1043. Ray, S. M. and William B. Wilson. 1957. THE EFFECTS OF UNIALGAL AND BACTERIA-FREE CULTURES OF GYMNODINIUM BREVIS ON FISH AND NOTES ON RELATED STUDIES WITH BACTERIA. U. S. Fish and Wildlife Service Spec. Sci. Rep-Fish. No. 211, in press, 50 pp.

This investigation was conducted to determine the effects of Gymnodinium brevis Davis, a naked dinoflagellate definitely associated with the sporadic mass mortality of marine animals in the Gulf of Mexico, on fish under controlled conditions. A series of experiments, seven with unialgal cultures and two with bacteria-free cultures, demonstrated the toxicity of this organism to six species of fish. Bacteria-free cultures were just as toxic as unialgal cultures. The cultures employed contained 0.6 to 4.8 million G. brevis per liter. Apparently the test fish were differentially sensitive to G. brevis cultures. In order of decreasing sensitivity the test fish were: Membras vagrans, Mugil cephalus, Fundulus grandis, Mollienisia latipinna, Fundulus similis, and Cyprinodon variegatus. The lethality of bacteria-free G. brevis cultures to fish clearly indicates that this dinoflagellate is the direct cause of the mass fish mortalities with which its "blooms" are associated.

Toxicity of G. brevis cultures does not depend on the presence of living organisms. The more toxic portion of the cultures passes through a millipore membrane whereas it is retained by filter paper. In some experiments such possible lethal factors as oxygen deficiency, suffocation due to clogging of gills with masses of organisms, and bacterial growth were eliminated thereby establishing that G. brevis produces a toxic substance(s).

Two chromogenic marine bacteria, Flavobacterium piscicida Bein and an unidentified red-pigment-producing form, from the west coast of Florida were tested for toxicity to fish. The results of these tests are discussed. (Auth. abst.)

1044. Yuen, Heeny S. H. and Fred C. June. 1957. YELLOWFIN TUNA SPAWNING IN THE CENTRAL EQUATORIAL PACIFIC. Fish. Bull. 112, Vol. 57, U. S. Fish and Wildlife Service, pp. 251-264.

Material for this report was furnished by 740 laboratory determinations, supplemented by field determinations, of the stage of maturity of ovaries of yellowfin tuna (Neothunnus macropterus) caught in the central equatorial Pacific. The usual length at sexual maturity of yellowfin in this area was found to be about 120 cm., although yellowfin as small as 70 cm. may be mature. Spawning was found to occur throughout the area surveyed (approximately 10° N. to 8° S. latitude, 120° W. to 180° longitude). Other studies have indicated that this area is but part of a band of yellowfin spawning grounds which covers the entire equatorial Pacific.

In this investigation, residual eggs in various stages of resorption were examined and described. Of 25 ovaries examined, 22 were found to be infested with unidentified nematodes ranging from 0.5 to 4 cm. in length. The number of worms in an ovary was usually less than five, and the infestation did not appear serious enough to affect the function of the ovary. (Auth. abst.)

1045. Fleminger, Abraham. 1957. NEW CALANOID COPEPODS OF THE FAMILIES AETIDEIDAE, EUCHAETIDAE, AND STEPHIDAE FROM THE GULF OF MEXICO. Fish. Bull. 117, Vol. 57, U.S. Fish and Wildlife Service, pp. 355-363.

Three new species of calanoid copepods are described from the extensive plankton collections of the M/V Alaska in the Gulf of Mexico between 1951-53. Bradyidius arnoldi, n. sp., resembles the female of B. armatus Giesbrecht, whereas in the male it is somewhat like B. similis (Sars). Euchaeta paraconcinna, n. sp., is related to E. concinna Dana. Stephos deichmannae, n. sp., appears to be most closely related to a group of European species including S. scotti Sars, S. fultoni Scott and Scott, and S. gyrans (Giesbrecht).

1046. Brett, J. R. 1956. SOME PRINCIPLES IN THE THERMAL REQUIREMENTS OF FISHES. The Quart. Rev. of Biology., Vol. 31, No. 2, June, pp. 75-87.

Among aquatic gill-respiring vertebrates there is no escape from environmental temperature. Tissue temperature and environmental temperature are constantly equilibrated at the gill surfaces. Although the thermal requirements for fish have been seen to fall in a number of categories, the fundamental requirement can be restated—an external temperature best suited to the internal

tissues. The tissues themselves are functionally adapted to a wide thermal tolerance, which is bounded by lethal limits and shows great diversity between species.

In general, cold-water fishes have a lower level of thermal tolerance than inhabitants of warmer waters. Through reversible acclimation, which is more rapid for a rising temperature than for a falling temperature, the degree of tolerance and the activity range is variously extended among species. A slow rate of decrease in environmental temperature is of greater importance for maintaining life than a slow rate of increase.

The combined information concerning lethal temperature and temperature permitting maximum activity, at all stages of development, is necessary for an interpretation of temperature in terms of survival value. Where high temperature does not limit activity, lethal levels can be expected to be a prominent environmental factor in setting the limits of distribution.

The scope for activity of cold-water fishes finds maximum expression at moderately low temperatures, which appear to be those frequented by the fish as preferred temperatures. A potential for delicate discrimination of temperature differences among diverse species of fish is probably only exercised under particular environmental conditions.

Temperature, then, may act in the capacity of a lethal factor; it constantly conditions the fish through acclimation while governing the scope for metabolic rate; performance is best in the region of the preferred temperature; and a sensitivity to small gradients of temperature may act as a directive factor. Undoubtedly, the role of temperature among fish is a multiple one. (Auth. Summ.)

1047. Wood, Roy, Richard H. Macomber and Robert K. Franz. 1956. TRENDS IN FISHING PRESSURE AND CATCH, ALLATOONA RESERVOIR, GEORGIA, 1950-53. J. Tenn. Acad. of Sci., Vol. 31, No. 3, July, pp. 215-223.

Allatoona Reservoir, comprising 11,300 acres at power pool elevation, is located approximately 35 miles northwest of Atlanta on the Etawah River. Impoundment began in the winter of 1949-50. Creel census studies were conducted from July 1, 1950 to June 30, 1953.

Total fishing pressure amounted to 170,725 fisherman-days from July 1, 1950 to June 30, 1951, 189,646 fisherman-days the second year, and 91,244 fisherman-days the third year. In 1950-51, boat fishermen caught an average of 0.66 fish per hour; in 1951-52, 0.21 fish per hour; in 1952-53, 0.11 fish per hour, indicating an over-all reduction in fishing success of about 83 percent. In terms of weight of fish caught per hour by boat fishermen, fishing success was 79 percent less the third year than in the first year. Hourly success of bank fishermen declined similarly during these three years, the reduction amounting to 74 percent by number and 67 percent by weight.

Decline in fishing success may be attributed to population changes. Carp contributed the most of any species during the first year in maintaining the high fishing pressure. Carp continued to be the dominant fish taken until the third year when a sharp decline in percentage of catch by numbers and weight was recorded. The number caught and rate of catch of largemouth bass and spotted bass also declined. Black crappie failed to comprise an appreciable percentage of the catch the first and second years because of their small size. Similarly, bluegill have been of little importance due to small size.

1048. Reid, George K. 1956. ECOLOGICAL INVESTIGATIONS IN A DISTURBED TEXAS COASTAL ESTUARY. The Texas J. of Sci., Vol. 8, No. 3, Sept., pp. 296-327.

Rollover Pass, a cut through Bolivar Penninsula on the Gulf coast of eastern Texas, was constructed in January 1955, and introduced Gulf waters of high salinity into the upper portion of East Bay. A study of some of the hydrographic and biologic aspects was made in June and July 1954, prior to the construction of the pass (see abstrs. 552-553). The present study was concerned with ascertaining what changes occurred in the physical, chemical and biological characteristics of the bay following the excavation of the pass. Field investigations were carried on from June 7 through June 30, 1955. Collections were made in the bay by means of three otter trawl modifications, seine, and trammel net. Observations were made of sport catches.

Marked differences between the salinity in June 1954, and June 1955, in East Bay were noted. During the 1954 study, a rather typical estuarine salinity gradient existed. The bay during June 1955, contained water of high salinity in the upper region; less saline conditions occurred in the lower area. A nearly two-fold increase in salinity from 1954 to 1955 was detected in the upper area. Temperatures were comparable for the two investigations. Turbidity was slightly greater in the upper bay in 1955 than in 1954.

The number of species of fishes in 1955 (51 forms) was nearly the same as for 1954 (50 species). However, nine forms recorded in 1954 were not noted in 1955. Ten species were found in 1955 which were not caught in 1954, and some of these were salt-loving species whose presence reflected the increased salinity in the bay. Over 24,000 specimens were caught by all gear in the bay. Represented in the catch were 51 species, 47 genera, and 26 families. Most of the fish population mass in 1955 was composed of the same species which made up the bulk of the catch in 1954. Noticeable increases in the catches of menhaden and anchovy were recorded, while the relative abundance of young croaker and spot appeared to be less in 1955 than in 1954. The proportions of the various species in the 1955 catch varied also from those of 1954. Three species of shrimps were found in the bay during the 1955 study. The brown shrimp was less abundant and the white shrimp more abundant than in 1954. The sea bob, not caught in 1954, was taken in 1955. (Auth. summ.)

1049. Eggleton, Frank E. 1956. LIMNOLOGY OF A MEROMICTIC, INTERGLACIAL, PLUNGE-BASIN LAKE. Reprint from Trans. of the Amer.

Microscopical Soc., Vol. 75, No. 3, July, pp. 334-378.

Fayetteville Green Lake, located near Syracuse, New York is about 0.75 miles long, nearly 59 meters deep, and both dichothermic and meromictic. An investigation, begun in 1925, has been continued at infrequent and irregular intervals since that date. Green Lake has one surface inlet, an outlet which has a somewhat greater volume than its one visible inlet, and a remarkably constant water level. Massive biherms of marl have been deposited in many places around the shore line which drops precipitously into deep water. Although these biherms do not occupy a major portion of the whole shore line, marl is a major constituent of the bottom deposits.

The dichothermic gradient usually presents a stratum of coldest water (varying from 4.0° C. in April to 6.8° C. in September) which lies between 15 and 25 meters. The level of this stratum is higher in the spring; lower in the fall. Warmer water always lies both above and below it from April to November. At times a true katothermal thermocline (negative thermal gradient) may develop just beneath the level of minimal temperature which then may lie just at the bottom of the normal thermocline. Present evidence indicates that Fayetteville Green Lake probably never turns over in either spring or fall and, therefore, is permanently stratified, both thermally and chemically. The most striking physico-chemical features of the lake are the sharpness, persistence, and uniformity of thermal and chemical stratification. The abrupt changes usually occur within the 15 to 25-meter stratum. There is always oxygen above 15 meters, never any below 25 meters. Hydrogen sulfide is always absent above 15 meters, always present (in concentrations up to more than 30 ppm.) below 25 meters. Hydrogen ion-concentration varies from pH 7.7 to 8.0 at the surface but is usually 6.8 at the bottom.

The zooplankton is typically dominated by a few species of Copepoda, mostly of the genus Diaptomus, but during the summer of 1936 Mysis oculata relicta (Loren) was collected at all levels from 40 feet to the surface. Bottom deposits, other than marl, are mostly an "organic ooze" that is greasy to the touch, very offensive in odor, and jet black in color. Rooted aquatic plants include Chara, by far the most abundant, some Elodea, a few thin patches of Potamogeton and some fairly extensive areas of an aquatic moss. Algae form an important association, principally on the great bioherms. Almost no macroscopic benthic animals have been collected below a depth of 4 or 5 meters and none below 20 meters. The restricted littoral benthis fauna is neither greatly diversified nor quantitatively rich. It is mostly composed of gastropods (six species), crustaceans, and insects. (From auth. summ.)

1050. Broadhead, Gordon C. 1957. CHANGES IN THE SIZE STRUCTURE OF THE YELLOWFIN TUNA POPULATION OF THE TROPICAL EASTERN PACIFIC OCEAN FROM 1947 to 1955. Inter-Amer. Tropical Tuna Comm., Bull., Vol. 11, No. 1, 10 pp.

Both analysis of logbook data and study of hook sizes used by the fishing fleet indicate that in recent years, coincident with the higher fishing intensities, there has been an increase in the proportion of small yellowfin tuna in the catch from the Eastern Pacific. Whether the availability to the commercial fishery of the various sizes of yellowfin tuna remains the same each year is difficult to assess. It is possible, though very unlikely, that some or all the size changes shown by the logbook and the hook-size data are due to some systematic change in availability of these larger fish, the correlation with changes in fishing effort being purely fortuitous. It is also possible that the changes in size composition may have been due to variations in year class strength resulting from factors other than the intensity of fishing, and that the correlation between changes in fishing effort and changes in size composition is a chance event. This would seem to be unlikely. The general indications of changes in the average size of the yellowfin tuna landed by the commercial fishery, correlated with changes in the fishing effort during the past decade, while not entirely conclusive, corroborate the strong statistical evidence that the recent levels of fishing intensity have been sufficiently high to affect the stocks of yellowfin tuna in the Eastern Tropical Pacific, and further suggest that the returns from tagging experiments are far below the true levels of exploitation of the stocks. (From auth. summ.)

1051. Mraz, Donald and Edwin L. Cooper. 1957. NATURAL REPRODUCTION AND SURVIVAL OF CARP IN SMALL PONDS. Reprint from the J. of Wild. Mgt., Vol. 21, No. 1, Jan., pp. 66-69.

These experiments were designed to test the idea that population density of adult carp is an important factor in the success of natural reproduction of this species. Thirteen trials were made in small ponds during a 3-year period utilizing stocking rates ranging from 37.5 pounds per acre to 450 pounds per acre of adult carp. The standing crop of young carp at the time of draining the ponds after one summer's operation ranged from 98.4 to 319.1 pounds per acre. There was little apparent correlation between the standing crop of adult fish stocked in ponds and the standing crop of young fish produced during the first summer. From the present experiments, the control of carp in lakes cannot be economically justified where carp populations are small. Also, there is no reason to expect a sudden increase in reproduction resulting from an intensive removal of adult carp. (Auth. summ.)

1052. Cuerrier, J. P. and Fred H. Schultz. 1957. STUDIES OF LAKE TROUT AND COMMON WHITEFISH IN WATERTON LAKES, WATERTON LAKES NATIONAL PARK, ALBERTA. Wildl. Mgt. Bull., Series 3, No. 5, Can. Dept. of Northern Affairs, Jan., 41 pp.

The fish populations of Upper and Lower Waterton Lakes were investigated in 1951. Although their physical and chemical conditions differ, both lakes are oligotrophic and of the sub-alpine type. Lake

trout, especially in Lower Lake, exhibited excellent condition and rate of growth. This is believed to be due to: (1) the population was adequate but not dense; (2) common whitefish, their most common food item, were abundant; (3) few other species were competing for whitefish; (4) the water was clear, mildly alkaline, contained a fair amount of dissolved minerals, and had ample oxygen at all depths during the ice-free season; and (5) no thermocline formed.

Lake trout examined were from 3 to 16 years of age: the 6-, 7-, and 8-year age-classes appeared large. Common whitefish examined were from 2 to 13 years of age; most were in the 3- and 4-year age-classes. Though lake trout growth was exceptional, the growth rate of whitefish was found to be slower than in other Canadian lakes. (From auth. summ.)

1053. Nicholson, A. J 1957. SUMMARY OF SPORTSMEN'S EXPENDITURES, MISSOURI RIVER BASIN. Spec. Sci. Rep: Wildlife No. 35, U. S. Fish and Wildlife Service, March, 15 pp.

Data obtained during 45 sportsman-expenditure studies conducted by the Fish and Wildlife Service in the Missouri River Basin are tabulated. Of these studies, 10 were concerned with warm-water fishing, 22 with cold-water fishing, 1 with annual and investment expenditures of licensed sportsmen in 3 Montana counties, and the others with wildlife. The component parts of the sportsman's daily expenditure and the expenditure per pound of fish harvested are shown.

1054. Dendy, Jack S. 1956. BOTTOM FAUNA IN PONDS WITH LARGEMOUTH BASS ONLY AND WITH A COMBINATION OF LARGEMOUTH BASS PLUS BLUEGILL. J. of the Tenn. Acad. of Sci., Vol. 31, No. 3, July, pp. 198-207.

Bottom organisms were studied in two ponds, one stocked with largemouth bass only and the other with largemouth bass plus bluegill. Both ponds were enriched with essentially the same amount of fertilizer per acre.

During periods of stratification bottom animals in the bass-only pond were very abundant at depths of 5 to 7 feet, but in the bass-bluegill pond no such concentration developed. When the water was not stratified the benthic faunas were more widely dispersed and the population of these animals in the bass-bluegill pond increased a great deal. The bass-bluegill population used the available food efficiently and yielded good harvests to anglers amounting to 169 and 132 pounds per acre in consecutive years while without the bluegill the bass made poor use of bottom organisms and yielded only 42 and 20 pounds per acre to the anglers. It is concluded that when studies of bottom organisms are to be used to evaluate the productivity of a body of water, a knowledge of the fish population and other ecological factors seem to be essential in making interpretations. (Auth. summ.)

1055. Hubbs, Carl L. 1955. HYBRIDIZATION BETWEEN FISH SPECIES IN NATURE. Systematic Zoology, Vol. 4, pp. 1-20.

This is a comprehensive discussion of hybridization with particular emphasis on research by the author on this subject conducted over the past 35 years. Two conclusions stand out, (1) that frequency of hybridization, like speciation in general, is to a large degree a function of the environment, and (2) that among marine fishes in general, as contrasted with northern fresh-water fishes, hybrids are excessively rare. Frequent hybridization in fresh waters may be attributed in part to the greater opportunity for chance meeting of egg and sperm, but, more especially to the ephemeral and changing nature of the fresh-water environment compared to that of the salt-water environment. Contrast in regional incidence of hybridization may probably be drawn also between temperate and tropical regions. Available information indicates this to be true but comparable investigations have not been made in both regions; most of the few recognized marine hybrids have come from temperate northern waters, but this may only reflect the more complete studies there.

Frequency of hybridization also appears to be inversely correlated to the number of species in given areas. In the Catostomidae, and, likely, also in the Cyprinidae, hybridization is more frequent in fresh waters of western North America than in the more speciose water of eastern North America; hybridization seems least common in the abounding fauna of the tropics. The absence or scarcity of hybridization where species are most numerous is one of several lines of evidence that belittle interspecific hybridization as an important factor in the speciation of fishes. Frequent, if not usual, sterility or partial sterility of hybrids is another of the lines of evidence. Considerable evidence, however, indicates that in at least some groups in certain regions crossing of the species line has been a factor of some significance in speciation, particularly in the way of introgressive hybridization.

Tabular material included in this paper presents recognized hybrids, natural and artificial, for genera and subgenera of Catostomidae, Cyprinidae, Cyprinodontidae, Poeciliidae, Percidae, and Centrarchidae.

1056. Anonymous. 1957. FISH PROTECTION AT THE TRACY PUMPING PLANT, CENTRAL VALLEY PROJECT, CALIFORNIA. (Development of a fish salvage facility). 96 pp., illus., multilith., pub. by U. S. Dept. of the Interior, Bureau of Reclamation, Sacramento, Calif. Feb.

The Tracy Pumping Plant, designed to lift a maximum of 4,600 cubic feet of water per second 197 feet into the 117-mile Delta Mendota Canal, draws water from the combined flows of the Sacramento, San Joaquin, and other streams entering the Delta area at the head of San Francisco Bay. Because of the great importance of the Delta area to downstream migrant salmon and as a spawning and rearing area for striped bass and shad, adequate screening facilities were a necessary protective feature.

Approximately three years have been spent at a

pilot structure studying the problems concerned with screening such large volumes of water, so many sizes and species of fish, and large amounts of minute debris. Sufficient information has been obtained to design a permanent fish collecting facility using the newly developed louver principle. Essentially this is a row of verticle slats or louvers, each set at a sharp angle to the direction of flow. Design criteria adopted are: (1) the angle of the louver system in the channel may vary between 10° and 15° with the direction of flow; (2) louver slats should be placed at 90° to the direction of flow; (3) the average maximum velocity of water in the channel as it approaches the louver system should not exceed 5.3 feet per second; (4) a trashrack should be built ahead of the louver system and there should be a minimum of 25 feet of non-turbulent flow; (5) bypasses for entry of fish diverted by the louvers should be about 75 feet apart; (6) bypass openings should be 6 inches wide; (7) trashrack bars should have a clear opening of two inches; and (8) provision should be made for installation of a saline bath arrangement in the event that young striped bass suffer shock.

Effectiveness in collecting fish is the primary advantage of the louver system over other types. The louver system collected 90 percent of 25 mm. striped bass and 90 percent of 16 mm. striped bass while the only alternative, travelling screens, collected 47 percent of the 25 mm. size and only 7 percent of the 16 mm. size. In addition, the louver system diverts fish without handling thus avoiding shock, is subject to a minimum of wear since it has no moving parts, and requires a minimum of attendance, and has lower initial costs and maintenance costs than a travelling-screen system.

1057. Kimsey, J. B. 1957. THE STATUS OF THE REDEYE BASS IN CALIFORNIA. Calif. Fish and Game, Vol. 43, No. 1, pp. 99-100.

The redeye bass (Micropterus coosae) was introduced into California in 1953. The 40 individuals were placed in hatchery ponds. Reproduction was obtained in 1954. During 1955 both the brood stock and reproduction died. This species is not now a part of the California fauna. (A).

1058. Reimers, Norman. 1957. SOME ASPECTS OF THE RELATION BETWEEN STREAM FOODS AND TROUT SURVIVAL. Calif. Fish and Game, Vol. 43, No. 1, pp. 43-69.

Winter trout food availability, trout vitality, and trout survival as related to food were studied during the period 1952-56 at Convict Creek Station, located at 7,200 feet in the Sierra Nevada of California. Stream bottom sampling after prolonged ice and snow cover demonstrated that a severe winter reduces the bottom fauna of a small stream drastically below the normal condition to a point where intake of food by trout must be negligible. Frequent anchor ice action gradually reduces the bottom food supply. Drift foods were more abundant relative to the bottom food supply in February and March when anchor ice action prevailed than later in the spring, but lack of feeding selectivity reduced any advantage the trout might gain from increased drift foods. Analysis of the stomach contents of 66 trout taken in February indicated an extremely low intake of food in an average winter month (0.16 cc. of ingested material, consisting of 40 percent food and 60 percent debris, per stomach).

Controlled feeding of natural food organisms showed trout digestion to be very slow at temperatures near the freezing point and progressively more efficient at higher temperatures. Time required for complete digestion of half-gram meals ranged from 12 hours for soft-bodied food organisms at 49° to 53° F. to 70 hours for hard-bodied insects at 32° to 33° F. It was deduced that the amount of nourishment obtainable from available food in extremely cold water is controlled primarily by the rate of assimilation, so that the low food supply associated with severe winter stream conditions cannot by itself be regarded as a crucial factor in trout survival. Results of several starvation trials indicated survival without food is favored by cold water and high initial fish condition. Mortality of trout starved in the stream, subject to ice, snow, and flow variations, was double that of trout starved in complete shelter. Hatchery rainbow trout 6 to 8 inches long survived 6 months over-winter starvation at 98 percent, recovered when feeding was resumed. Similar trout survived 4 months summer-fall starvation with temperatures up to 72° F. at 98 percent, but wild brown trout survived at only 18 percent. Conclusions: (1) healthy trout are capable of long periods of fasting, particularly in cold water; (2) planted trout need not make immediate heavy food demands on the environment; (3) competition for stream foods is a small factor in survival of well-nourished hatchery-planted trout to the creel of the year. (Auth. abst.)

1059. Nielson, Reed S., Norman Reimers and Harry D. Kennedy. 1957. A SIX-YEAR STUDY OF THE SURVIVAL AND VITALITY OF HATCHERY-REARED RAINBOW TROUT OF CATCHABLE SIZE IN CONVICT CREEK, CALIFORNIA. Calif. Fish and Game, Vol. 43, No. 1, pp. 5-42.

Experiments at Convict Creek Station of the U. S. Fish and Wildlife Service compared the survival and vitality of hatchery-reared, catchable-size, spring- and fall-spawning rainbow trout and wild brown trout of comparable size on a year-long basis for 4 years (May 1950 to June 1954) and the survival of hatchery-reared, fall-spawning rainbow trout of catchable size stocked in the fall for 2 seasons (1954-55 and 1955-56). Experimental facilities consist of four 1/4-mile sections of stream separated by concrete screen structures. The natural density of the wild trout population in a 3/4-mile section of Convict Creek closed to angling for 7 years was 120 pounds per acre. Wild brown trout used in the experiments were obtained from open sections of the stream. Rainbow trout were hatched and reared at Hot Creek Hatchery of the California Department of Fish and Game and the program was conducted in cooperation with that agency. Four years of year-long experiments, in which both

subspecies of trout were stocked alone and in various combinations at population densities ranging from 50 to 250 pounds per acre (initial spring stocking), demonstrated that the survival and vitality of the hatchery-reared trout was equal to that of the wild trout. The average of summer and winter survivals was 52.5 percent for hatchery rainbow trout and 50.7 percent for wild brown trout. The existence of either inter-species or intra-species competition was not indicated and survival was not demonstrated to be influenced by differences in stocking density within the ranges tested. Hatchery rainbow trout stocked in the fall (August 1, September 1, October 1, and November 1) in 2 seasons had average survivals of 54.0 percent and 81.2 percent the following June. Winter was more severe and protracted the first season. The number and quality of pools in the stream sections were shown to be influential in the over-winter survival of hatchery trout under severe conditions but not in milder circumstances. The average survival of the fall-stocked trout for the 2 years was 67.6 percent in comparison with 60.8 percent for those stocked in the spring of 4 successive years considering equal periods of residence in the stream. There was never a case of high initial mortality among the hatchery trout after stocking. (Auth. abst.)

1060. Kimsey, J. B. 1957. LARGEMOUTH BASS TAGGING AT CLEAR LAKE, LAKE COUNTY, CALIFORNIA. Calif. Fish and Game, Vol. 43, No. 2, April, pp. 111-118.

A tagging study at Clear Lake, which started in June 1953, and terminated in March 1954, tagged 441 largemouth bass. The jaw tags proved unsatisfactory and so were discontinued and not used in the calculation of vital statistics. There was no difference in the return of the staple and disk-dangler tags, so they were treated together. A total of 333 disk-dangler and staple tags was placed. In 3 years 94 (28.2 percent) were returned. Of this total, 54 (57.4 percent of total return) were received the first year, 37 (39.4 percent of total return) the second year, and 3 (3.2 percent of the total return) the third year.

In general, the migration of largemouth bass in Clear Lake is undirected, although there is some indication that fish in the shallower northern section are more sedentary. Survival was calculated to be 44 percent. The annual expectation of death is therefore 56 percent. Of this annual mortality, 20 percent is attributed to fishing and 36 percent to natural causes. Overfishing is not a problem, but the extent to which the take can be increased is unknown at this time. (Auth. summ.)

1061. Robertson, O. H. 1957. SURVIVAL OF PRECOCIOUSLY MATURE KING SALMON MALE PARR (ONCORHYNCHUS TSHAWYTSCHA JUV.) AFTER SPAWNING. Calif. Fish and Game, Vol. 43, No. 2, April, pp. 119-129.

As an approach to the study of the nature of post-spawning death of the Pacific salmons, an experiment was conducted to determine the fate of certain king salmon parr which mature sexually in their first year of life. Sixty such ripe parr were held in a hatchery trough, together with 120 immature controls, 61 of which were later found to be male fish. Autopsy of other mature parr from the same population showed relatively huge testes, comprising as much as one-fourth of the body weight. Test of the maturity of the sperm of these fish was made by fertilizing the eggs of adult females. The eggs hatched and the young salmon developed normally.

At the end of five months the spent males had survived and grown as well as the immature controls. Histological examination of the testes of the ripe parr taken at the beginning of the experiment showed them to be completely mature or partially spent. Five months later the spent parr exhibited renewed spermatogenesis, while the controls had infantile testes. Age appears to be the deciding factor in determining death or survival of this species of salmon following spawning. (Auth. summ.)

1062. Feinstein, Anita. 1956. CORRELATIONS OF VARIOUS AMBIENT PHENOMENA WITH RED TIDE OUTBREAKS ON THE FLORIDA WEST COAST. Reprint from Bull. of Mar. Sci. of the Gulf and Caribbean, Vol. 6, No. 3, Sept., pp. 209-232.

Investigations have been made to determine whether any simple, linear correlations exist between Red Tide outbreaks and various ambient phenomena. Outbreaks are compared with rainfall, tropical disturbances, and river runoff. A pattern of cyclic recurrence of outbreaks is presented. An attempt is made to show the path of individual outbreaks. (Auth. abst.)

1063. Wolf, Ken and C. E. Dunbar. 1957. STRAIN DIFFERENCES IN A FISH-PATHOGENIC CORYNEBACTERIUM. Bact. Proc., Abstr. No. A57, p. 25.

An eastern and a western strain of kidney disease bacteria were used for disease transmission trials with eastern brook trout at 12.5° C. for 101 days. Fish were fed bacteria, bacteria with splintered glass, or bacteria with bile salts. Neither strain of bacteria established infection per os. Some lots of fish were manually abraded, others were forced to self-abrasion in the presence of bacteria. Eastern strain bacteria readily established infection in many fish within 48 to 96 days. Western strain bacteria had established infection in about 1 percent of the fish, but more than 100 days after the 101-day period of attempted transmission were required. (Auth. abst.)

1064. Laakso, Martin. 1956. BODY-SCALE REGRESSIONS IN JUVENILE CUTTHROAT FROM YELLOWSTONE LAKE. Proc. Utah Acad. of Sci., Arts, and Letters, Vol. 33, pp. 107-111.

The body-scale regressions of juvenile cutthroat trout from different areas in Yellowstone Lake showed significant differences in slope. Curves plotted for fingerlings captured near the outlet of Yellowstone Lake exhibited steeper slopes, showing that scale growth was relatively faster than in fish collected along the lakeshore and in two small

tributaries. (Auth. summ.)

1065. Robins, C. Richard. 1957. A STUDY OF BLUEFIN TUNA POPULATIONS FROM THE EASTERN AND WESTERN NORTH ATLANTIC BASED ON AN ANALYSIS OF FIN-RAY AND GILL-RAKER COUNTS. The Chas. F. Johnson Oceanic Gamefish Inves., The Mar. Lab., Univ. of Miami, Publ. 57-13, ML 16197, 7 pp., mimeo.

On the basis of characters analyzed to date, i.e. dorsal spines, rays and finlets, anal rays and finlets and gill rakers, there is no evidence to support the existence of two species or subspecies of bluefin tuna in the Atlantic. T. secundodorsalis is synonymized with T. thynnus. The absence of demonstrable divergence between eastern and western Atlantic samples suggests that there is sufficient interchange of populations to prevent divergence, or that such an interchange occurred at a relatively recent time. Smaller specimens have fewer finlets but correspondingly more dorsal and anal rays than do the larger fish. Populational comparisons of tunas thus must either treat only fish of comparable sizes or deal with the combined counts. California specimens have fewer gill rakers than do Atlantic bluefin tunas. The two have diverged at least subspecifically and possibly represent separate species. The name T. saliens is available for the California bluefin tuna. Any final analysis of eastern and western Atlantic populations must await the study of external and internal body proportions. (Auth. concl.)

1066. King, Joseph E., Thomas S. Austin and Maxwell S. Doty. 1957. PRELIMINARY REPORT ON EXPEDITION EASTROPIC. U. S. Fish and Wildlife Serv., Spec. Sci. Rep.—Fish., No. 201, March, 155 pp.

This report describes the methods used and the results obtained, without analysis, in observations made aboard the research vessel Hugh M. Smith on the EASTROPIC expedition, a cooperative oceanographic survey of the central and eastern tropical Pacific, September-December 1955. Information was obtained on east-west gradients in temperature, salinity, phosphate, zooplankton, and forage-fish abundance. By means of closing-net hauls a special study was made of the vertical distribution of zooplankton. In collaboration with the University of Hawaii, carbon fixation and chlorophyll measurements were made on the east-to-west leg of the cruise. A survey of tuna baitfish was conducted in the Marquesas Islands. (Auth. abst.)

1067. Bowers, Charles C. and Mayo Martin. 1956. RESULTS OF AN OPENING WEEK CREEL CENSUS AND TAGGING STUDY ON THREE STATE-OWNED LAKES. Ky. Dept. of Fish and Wildlife Resources, Fish. Bull. No. 20, Oct., 13 pp.

The greatest concentrations of fishermen on Kentucky's state-owned lakes have been observed to occur during the first week following the opening of these lakes to fishing. To measure the impact of this surge of fishermen on an unsuspecting fish population, an opening week creel census and tagging study was conducted on three dissimilar state-owned lakes. In each lake bass were caught by angling and tagged. Tag returns were remarkably similar: 27 percent, 30.9 percent, and 27.5 percent. Evidence seemed to indicate strap jaw tags adversely affected the growth of tagged bass. In the creel census 70 percent of the largemouth bass caught in the first week from the three lakes were taken in the first 30 hours. The data indicates largemouth bass have a capacity for learning. The bluegill catch was small. A different opening date is recommended (Auth. abst.)

1068. Campbell, R. N. 1957. THE EFFECT OF FLOODING ON THE GROWTH RATE OF BROWN TROUT IN LOCH TUMMEL. Scottish Home Dept., Freshwater and Salmon Fish. Res., No. 14, 7 pp.

An account is given of the effect of raising the level of Loch Tummel on the growth rate of trout in the loch. The level of this loch was raised during 1950. In order to assess the effects of flooding on growth rate as clearly as possible, it was found necessary to determine how long the trout had spent in their nursery streams before migrating to the loch. Most of the fish, 51 percent, had spent 2 years in the nursery streams before migrating, 27 percent had spent 3 years and 15 percent had left the nursery stream after one year. The most marked increases in growth rate were shown by 2- and 3-stream-year-trout, the 1-stream-year fish generally showed less response. The increased growth rate produced by flooding was only shown during 1950 and 1951. In 1952 the rate of growth decreased markedly, particularly in the older fish. The reasons for the increased growth rate shown during 1950 and 1951 are discussed and it is suggested that earthworms might have provided the increased food supply which produced the higher rate of growth. (Auth. summ.)

1069. Greenbank, John. 1957. CREEL CENSUS ON THE UPPER MISSISSIPPI RIVER. U. S. Dept. of the Interior, Fish and Wildlife Service Spec. Sci. Rep.—Fish. No. 202, March, 59 pp.

Two summer and two winter seasons of creel census on the section of the Upper Mississippi River, between Red Wing, Minnesota, and Dubuque, Iowa, in 1944-46, showed the catch to be about 0.5 fish per hour, with a wide variety of fish represented, crappies, bluegill walleye, and sauger being predominant. The fishery is important especially to the local fishermen. The fishing success was about the same in the winter as in the summer. Wide fluctuations occurred from one locality to another, and from week to week. Fishing success varied from year to year; it was better in 1948-49 than in 1944-46. The catch per hour was influenced by several factors, such as bait, time of day, day of the week, sex of the fisherman, and probably water temperature (in the summer) and depth of snow cover (in the winter). For most practical pruposes, and in the interests of economy of data gathering, the sample size could be reduced; it is suggested that a census conducted on every fifth day would give results reliable enough for practical management purposes. (Auth. abst.)

1070. Parr, Albert E. 1956. ON THE ORIGINAL VARIATES OF TAXONOMY AND THEIR REGRESSIONS UPON SIZE IN FISHES. Bull. of the Am. Mus. of Nat. History, Vol. 110, Art. 5, pp. 373-397.

During ontogeny the proportions characteristic of a species, race, or population undergo changes which, in fishes, apparently continue throughout the life of the individual.

The processes of ontogeny are continuous. It is therefore not only necessary but should also be possible to use mathematical functions that will provide continuous approximations of the actual morphometric characters through all stages of growth.

Beyond the fitting of the data available, such functions must be of a form that will not at any point within the size range of the species indicate integral parts of the whole larger than the whole itself, or other conditions contrary to logic and experience. These requirements are easily met by polynomial series of low degrees fitted to the regression upon the whole of the ratio of parts to the whole or to one another.

For the general purposes of fish taxonomy, adequate first approximations can often be obtained from linear (first-degree polynomial) fuctions of the general form:

$$100\ y/x=a+bx$$

In other instances, and for purposes of second approximations, one may use functions of the forms of:

$$100\ y/x=a+bx+cx^2$$

or

$$100y/x=a+bx+cx^2+dx^3.$$

Many of the methods of fitting the data currently used and recommended in ichthyological research rest upon or lead to physically impossible assumptions. As a result, the regression functions developed by these methods are usually incapable of expressing the course of ontogeny beyond, or even to, the limits of the data available, which generally do not include a substantial lower portion of the size range of the species. As a further result, these functions are therefore also unsuitable as a basis for the continued development of our knowledge of the species as a whole, by an orderly process of gradual refinement and improvement instead of seriatim substitutions and abandonments.

That functions using low-degree polynomial series for the regressions of ratios upon the whole will actually fit available ichthyological data equally well or better than functions with physically impossible assumptions, previously applied to the same data, is demonstrated by many examples.

The absolute dimensions of variability are related to, and limited by, the absolute dimensions of the part and thus indirectly of the whole. Variability, measured in units of absolute length, must therefore also undergo a continuous process of change during ontogeny. Variability can accordingly not be expressed by absolute constants but must be described by continuous functions. It is suggested that individual deviations be measured, in first approximation, as percent of the whole, or in second approximation, as percent of the average size of the deviating part at the given length of the whole. Variances or other expressions of variability calculated from such measures of deviations will then take the form of continuous functions capable of fitting the entire course of ontogeny. (Auth. summ.)

1071. Voss, Gilbert L. 1956. THE CHARLES F. JOHNSON OCEANIC GAME-FISH INVESTIGATIONS. Prog. Rep. No. 2. (Summary of investigations for the period comprising Sept. 1955 through Aug. 1956.) Pub. by the Mar. Lab., Univ. of Miami, No. 56-23, 9 pp.

This report is concerned with findings of studies, initiated in January 1954, on the billfishes, comprising the sailfishes, spearfishes, marlins and the swordfish. Topics covered are systematics, geographical distribution, ecology, food habits, migration, spawning, and growth.

1072. Ellis, Robert W. 1956. TARPON COOPERATIVE RESEARCH PROGRAM PROGRESS REPORT. Mar. Lab., Univ. of Miami, Mar. Fish. Res., No. 56-20, July, 13 pp.

This report summarizes findings of the investigation started in May 1955. Tarpon biology including distribution and range, early life history, spawning habits, age and growth, and feeding habits, as well as tagging experiments and theories of migration are covered.

1073. Rychlicki, Z. and St. Zarnecki. 1957. DIE ZATOR KARPFENAUFZUCHTMETHODE UND DEREN EINFLUS AUF DIE BESEITIGUNG DER BAUCHWASSERSUCHT. (The role of the method of carp raising at the Zator station on the control of infectious dropsy). Zeitschrift für Fischerei, Vol. 5, No. 5-6, pp. 423-442.

Between 1934 and 1946, the Zator experimental fisheries station in southwestern Poland suffered great losses of carp caused by infectious dropsy. In 1946, a new management plan was introduced which is believed to be responsible for drastic reductions in loss of carp; losses have been negligible in one- and two-year-old carp, the chief product of the station. Main principles of the program are that the one-year-old carp are not transferred to winter ponds but kept over winter in nursery ponds, that the transfer of fish from the nursery ponds takes place late in spring when water temperatures are high enough for active metabolism, and that carp from different nursery ponds are never mixed in one production pond.

Before the introduction of the new management practices the annual losses amounted to 42 percent. With the new practices, they have been reduced to 10 percent, which is considered normal, and fish with symptoms of infectious dropsy have not been noticed. To test the effect of the time of handling of carp and transfer to other ponds on the outbreak of the disease, some yearling carp from one pond were transferred in early spring; they developed the typical dropsy. Another group of carp was handled and transferred in late spring; they remained free from

this disease.

Authors have formulated a hypothesis that infectious dropsy is most likely to break out when the handling of fish coincides with the period of adaptation from the winter to the summer conditions and when optimum conditions exist for the development of the pathogen. The susceptibility of the host to infection is believed to be a more important factor than the nature of the pathogen. This may explain while in addition to Aeromonas liquefaciens (Pseudomonas punctata) other bacteria and even viruses have been described by various authors as etiological agents of this disease. (S. F. S.)

1074. Collins, Eugene E. 1956. A MANUAL FOR OCEANOGRAPHIC OBSERVERS ABOARD U. S. FISH AND WILDLIFE SERVICE EXPLORATORY FISHERIES VESSELS. Spec. Rep. No. 23, Univ. of Wash., Dept. of Oceanography, May (Rev. July), 91 pp., ditto.

This report presents the procedures to be followed by oceanographic observers aboard U. S. Fish and Wildlife Exploratory Fisheries Vessels. Methods for obtaining water samples at depth, plankton hauls, bathythermograms, fish stomachs, secchi disk readings and dissolved oxygen are described in detail. A set of useful tables are included in the last Section. (Auth. abst.)

1075. Johnson, Fritz H. 1953. NOTES ON MORTALITY OF WALLEYE FINGERLINGS DURING AND FOLLOWING FIN-CLIPPING. Inves. Rep. No. 145, Minn. Dept. of Conservation, Div. of Game and Fish, Dec. 7, 6 pp., mimeo.

During the period August 31 to September 11, 1953, 67,648 walleye (Stizostedion v. vitreum) fingerlings were marked by fin-clipping for experimental stocking in Moose Lake, Itasca County, Minnesota. Length-frequency measurements of living non-fin-clipped and dead fin-clipped walleye fingerlings indicated that, on the average, large fingerlings withstand the handling necessary for this operation better than small fingerlings. A concentration of 0.25 percent urethane in water, used as an anesthetic, resulted in no increase in fin-clipping mortality and greatly facilitated in the fin-clipping operation. On a timed trial run 4,992 walleye fingerlings were fin-clipped by six biologists in 2.25 hours. This is an average rate of about 2,220 fish per hour or 37 per minute.

It was found that mortality rates incident to the fin-clipping operation could be reduced by allowing the walleye fingerlings to remain in holding tanks containing cool water for one night preceding the fin-clipping operation. It also appears desirable to keep them in the holding tanks during the night following clipping to decrease mortality immediately following stocking. Water temperatures below 70° F. appear to be desirable for handling and fin-clipping a large number of walleye fingerlings. Total mortality of walleye fingerlings for all phases of the marking and planting operation was 7.3 percent. However, it was found that with proper holding of the fish in cool water before clipping and stocking total mortality could be reduced to less than 5 percent. (Auth. summ.)

1076. Eschmeyer, Paul H. and Walter R. Crowe. 1955. THE MOVEMENT AND RECOVERY OF TAGGED WALLEYES IN MICHIGAN, 1929-1953. Misc. Pub. No. 8, Mich. Dept. of Conservation, June, 32 pp.

Of 2,783 walleyes marked with strap tags attached to the gill covers and released at five localities during the years 1929-1932, only 37 (1.3 percent) were subsequently recovered by anglers. No fish were recovered more than 6.5 months after tagging.

A total of 3,371 jaw-tagged walleyes were transferred to upstream impoundments from the Muskegon River below Newaygo Dam in 1947, 1948, and 1950. Of these, 617 (18.3 percent) were recovered by fishermen. Most (91 percent) of the recoveries were made during the first year after transfer. The transferred fish showed a marked proclivity to move downstream past power dams. The total number of passages across individual dams was 352, and three tagged walleyes successfully negotiated five of the structures, which were from 17 to 100 feet high. Of the walleyes stocked in the impoundments 18 percent had regained direct access to Lake Michigan by the time of recapture.

Of 765 walleyes tagged and released in the Muskegon River below Newaygo Dam in 1948 and 1950, 96 (12.5 percent) had been recovered by the end of 1953. A total of 38 walleyes released below Newaygo Dam and 45 fish released in the upstream impoundments were recaptured in Lake Michigan. Fourteen walleyes had traveled more than 100 miles between the date of release and recapture and one had moved 175 miles. Lake Michigan recoveries were scattered along the east shore from as far south as Porter Beach, Indiana, to as far north as Good Harbor Bay, points which are about 250 miles apart.

Of 395 native walleyes marked in 1948 and 1952 in Hardy Pond, the largest of the Muskegon River impoundments, 40 had been recovered by the end of 1953—8 of them in downstream waters, after having passed one or more of the power dams.

Returns from 568 jaw-tagged walleyes transferred in 1942 from the Cheboygan River below Cheboygan Dam to lakes and streams of the Inland Waterway numbered 64 (11.3 percent). The pattern of recoveries indicated extensive movement by the transferred fish (primarily upstream). Recaptures were spread over an unbroken span of 10 fishing seasons. Two walleyes were recovered more than 9 years after tagging.

A total of 103 (17.7 percent) of 582 native walleyes tagged in the Inland Waterway in 1948 and 1952 have been recovered to date. Movement of the fish among the lakes and streams of the Waterway was about as extensive as that of walleyes introduced from the lower Cheboygan River in the 1942 experiment.

Total returns from 5,161 walleyes tagged in the years 1939-1949 in five other localities in Michigan have equaled 373 (7.2 percent). The return to date from the grand total of 11,354 walleyes that have been jaw-tagged in Michigan during the period 1939-1952

is only 12.2 percent. This small return suggests that a large proportion of the walleyes in these representative waters never reach anglers' creels.

Growth was found to be retarded by the presence of jaw tags. The length increment of 37 Lake Gogebic walleyes recovered in 1947 after bearing tags during one growing season averaged less than two-thirds that of untagged fish. The condition of the fish was not affected by the tags. (Auth. summ.)

1077. McBirney, W. B. 1956. HYDRAULIC STUDIES OF FISH COLLECTING FACILITIES DELTA-MENDOTA INTAKE CANAL—CENTRAL VALLEY PROJECT, CALIFORNIA. Hydraulic Lab. Rep. Hyd-410, U. S. Dept. of the Interior, Bur. of Reclamation, July 26, 22pp., + maps, designs and pictures.

The purpose of this report is to assemble the results of the studies made in the Hydraulic Laboratory during 1955. The report consists of three main parts: the first deals with a model on 1:20 scale of the intake canal structure at Old River, including trashracks, trashramp, transition sections, and louver and fish by-pass sections. Considerable lengths of topography upstream and downstream of the structure were studied for erosion. The second part is concerned with a 1:4 scale model of one fish by-pass in the line of guide louvers below the transition section. The third part is devoted to studies of various proposals for sensing velocities at critical points within the collecting facilities.

This report may be considered as supplementary to Hyderaulic Laboratory Report No. 401, "Field and Laboratory Tests to Develop the Design of a Fish Screen Structure—Delta-Mendota Canal Headworks—Central Valley Project, California," in that the tests reported herein were performed on designs developed as an outgrowth of studies described in that earlier report. (Auth. summ.)

1078. Anonymous. 1956. OCEANOGRAPHY, FISHERIES, AND ATOMIC RADIATION. Science, Vol. 124, No. 3210, July 6, pp. 13-16.

This article is the text of the summary report of the Committee on the Effects of Atomic Radiation on Oceanography and Fisheries. The report is part of a continuing study on the Biological Effects of Atomic Radiation conducted by the National Academy of Sciences.

Disposal of radioactive waste materials is an infant problem demanding solution. It is similar in character to, though potentially far greater in scope than, other problems of pollution. Purification of waters (ultimately the oceans) receiving radioisotope waste will proceed only by dilution, by precipitation and settling on the bottoms, and by decay of radioactivity. Nothing could be done to reverse an undesirable accumulation that might result from ill-considered disposal of this type of waste.

The problems of disposal of wastes in the sea, the effects of such disposal on man's use of other resources of the sea, the urgency for long-range research on the physics, chemistry, and geology of the sea and on the biology of marine organisms, and the immediacy of the need for scientific effort on a world-wide basis are discussed. The opportunity for learning more about the sea through use of radioactive material is also stressed.

1079. Kelley, D. W. 1953. A STUDY OF THE SUITABILITY OF ABANDONED GRANITE QUARRIES NEAR ST. CLOUD, MINNESOTA, FOR PUT-AND-TAKE FISHING OF BROWN AND RAINBOW TROUT. Inves. Rep. No. 141, Minn. Dept. of Conservation, Div. of Game and Fish, Nov. 5, 9 pp., mimeo.

Eight abandoned granite quarries were studied in 1953 to determine their capabilities for supplying put-and-take fishing for brown and rainbow trout. Past fishing history suggested that returns from stocked catchable-size trout had been good. Four of the quarries had a shallow 7- to 12-foot thick layer of cool trout water and four had an 18- to 23-foot thick layer.

All planted trout were marked with a small jaw tag attached to the opercle; this method of marking proved to be unsatisfactory. Despite tag loss, however, 33 percent of tagged brown trout and 50 percent of the rainbow trout were taken by anglers. No consistent difference in tag returns was noted for the two quarry types. An index derived by dividing the percent tag return by the total number of fishermen counted during the creel census period for each quarry revealed no consistent difference in the capabilities of the two types of quarries to supply put-and-take fishing. However, this index did show that the quarries were three times more efficient in supplying put-and-take fishing for rainbow trout than for brown trout. (From auth. summ.)

1080. Hale, John G. 1954. REGENERATION OF PELVIC FINS ON FINGERLING BROOK TROUT FOLLOWING FIN CLIPPING. Inves. Rep. No. 149, Minn. Dept. of Conservation, Div. of Game and Fish, March 5, 3 pp., mimeo.

In order that fin regeneration could be observed, 290 3-inch trout whose pelvic fins had been removed as close to the base as possible with surgical scissors were held in troughs and checked after 10 months and 14 months and 10 days had elapsed. Of the trout which survived, 28.8 percent showed complete fin regeneration after 10 months and 31.5 percent showed complete regeneration after 14 months and 10 days. Considerable regeneration, i.e., one or both fins somewhat smaller and not spreading like a normal fin, was evident in 44.5 percent of the same lot of fish after 10 months and in 47.5 percent in 14 months and 10 days. Only 10 percent exhibited negligible or no fin regeneration. It is possible that this high degree of regeneration may have been due to the inexperience of the markers or the use of surgical scissors rather than bone forceps.

1081. Hale, John G. 1954. INVESTIGATIONS ON TROUT CATCH AND POPULATIONS IN THE WEST BRANCH OF THE SPLIT ROCK RIVER, LAKE COUNTY, MINNESOTA, 1951 to 1953. Inves. Rep.

No. 148, Minn. Dept. of Conservation, Div. of Game and Fish, March 5, 14 pp., mimeo.

A creel census on the Split Rock River, a small forest brook-trout stream in Lake County, Minnesota, showed an annual harvest of trout during the years 1951, 1952, and 1953 of 27.4, 49.2, and 34.1 pounds per acre and 161, 386, and 162 trout per acre. These figures are based on the 12.9 acres in which 99 percent of the anglers fished. In each of these years about 800 catchable trout (7 to 9 inches long) were planted; brown trout were planted in 1951 and brook trout in 1952 and 1953. This is a stocking rate of about 62 trout or about 7.2 pounds per acre of stream censused. All planted trout were marked by fin clipping.

Fishing pressure on the stream was 92.0 hours per acre in 1951, 228.8 in 1952, and 150.5 in 1953 and take of trout per man-hour in these years was 1.74, 1.70 and 1.07. Of the total number of fish caught, 1.8 percent were brown trout planted in 1951, 12.6 percent brook trout planted in 1952, and 10.8 percent brook trout planted in 1953. Of the brown trout planted in 1951, 2.6 percent were taken in that year; 79 percent of the brook trout planted in 1952 were taken; and 27 percent of the brook trout planted in 1953 were taken. Trout were planted in 1951 as a single stocking in May, but in 1952 and 1953 the brook trout were planted in three lots: one-half in April, one-fourth in June, and one-fourth in July.

Six stations, with a total area of 1.3 acres, were shocked with a stream shocker each September. Populations of trout found per acre were: 1951, 74 fish and 10.6 pounds; 1952, 208 fish and 20.3 pounds; and in 1953, 233 fish and 24.6 pounds. The weight per acre of the residual fall trout population in each year was considerably less than the average harvest per acre by anglers. Age-class distribution of the trout taken by shocker shows that an adequate breeding population of trout is left in the stream. (From auth. summ.)

1082. Tester, Albert L., P. B. van Weel, John J. Naughton and Sidney C. Hsiao. 1955. REACTION OF TUNAS TO STIMULI, 1952-53. U. S. Fish and Wildlife Service, Spec. Sci. Rep.-Fish. No. 130, March, 124 pp.

This study of the response of captive tunny to extracts of fish flesh, viscera, etc. and to certain chemicals in solution or suspension was conducted from June 1, 1952 to May 31, 1953. The tunas, caught by trolling, were transported to shore and established in a small concrete tank and a large pond at the Hawaii Marine Laboratory, Coconut Island, Oahu. For the most part, they were fed strips of tuna flesh 3 or 4 times a week and, on this diet, more than tripled their weight during the course of the year. Test substances were introduced into the tank or pond through a continous stream of water supplied by an electric pump. When and where possible, precautions were taken to avoid distraction of the fish by extraneous audio or visual stimuli.

When certain test substances such as clear aqueous or alcohol extracts of tuna flesh were introduced into the tank or pond, a response was obtained. This took the form of a feeding reaction and included one or all of the following components: speeding or acceleration of the swimming rate, a return to the area of distribution of the substance, surfacing, fanning-out and eventually a breakdown of school formation, circling, splashing, and biting at incidental objects on the surface of the water. Although a positive response was obvious to the observers, it was extremely difficult to measure quantitatively because of its complexity and also at times because of erratic behaviour of the fish.

It is postulated that in tuna flesh there is present a substance (or substances), herein called the attractant, which is perceived by the tunny. The attractant was present in the flesh, viscera, and blood of several species of tuna and also in the flesh and blood of certain white-fleshed fish, but was not present in beef blood. It was found in tuna cannery byproducts such as viscera preparations, stickwater, and fish meal. Much work was devoted to attempts at purification, fractionation, and identification of the unknown attractant. Its properties are summarized.

Some 40 chemical compounds were tested as time permitted, including certain amino acids, vitamins, aromatics, proteins, etc. In some, notably certain amino acids, vitamins, and aromatics, there appeared to be a sensing of the dissolved or suspended compound but the results could not be duplicated. In no case did the response include all of the components of a typical reaction to a tuna flesh extract.

The question arises as to what extent the typical response to extracts of tuna flesh and viscera is promoted by a conditioning of the tunny to life in captivity and, particularly, to the type of food fed and the method of feeding. There is evidence that the response was not conditioned by the type of food which was fed.

In a study of response to visual and visual-chemical stimuli, the activity of 12 little tunny in a large pond was observed during September 1952 under control conditions (no stimulation), when a pair of lures was dipped into the water once every 2 seconds, and when the lures were used together with stock extract of tuna flesh. As compared with control conditions, schools entered the area more frequently and spent more time in the area when stimulated with lures, and still more frequently and for longer periods when stimulated with lures plus extract. The difference between mean number of entrances under control, lures, and lures with extract is statistically significant. However, the difference in relative time spent in the area between the two experimental conditions is not statistically significant. Although, in general, the fish made more passes at white as compared with colored lures, the superiority of the white lures was slight. It may have been associated with greater visibility rather than color preference. There is no assurance that white lures would be superior to colored lures in the open sea. (From auth. summ.)

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